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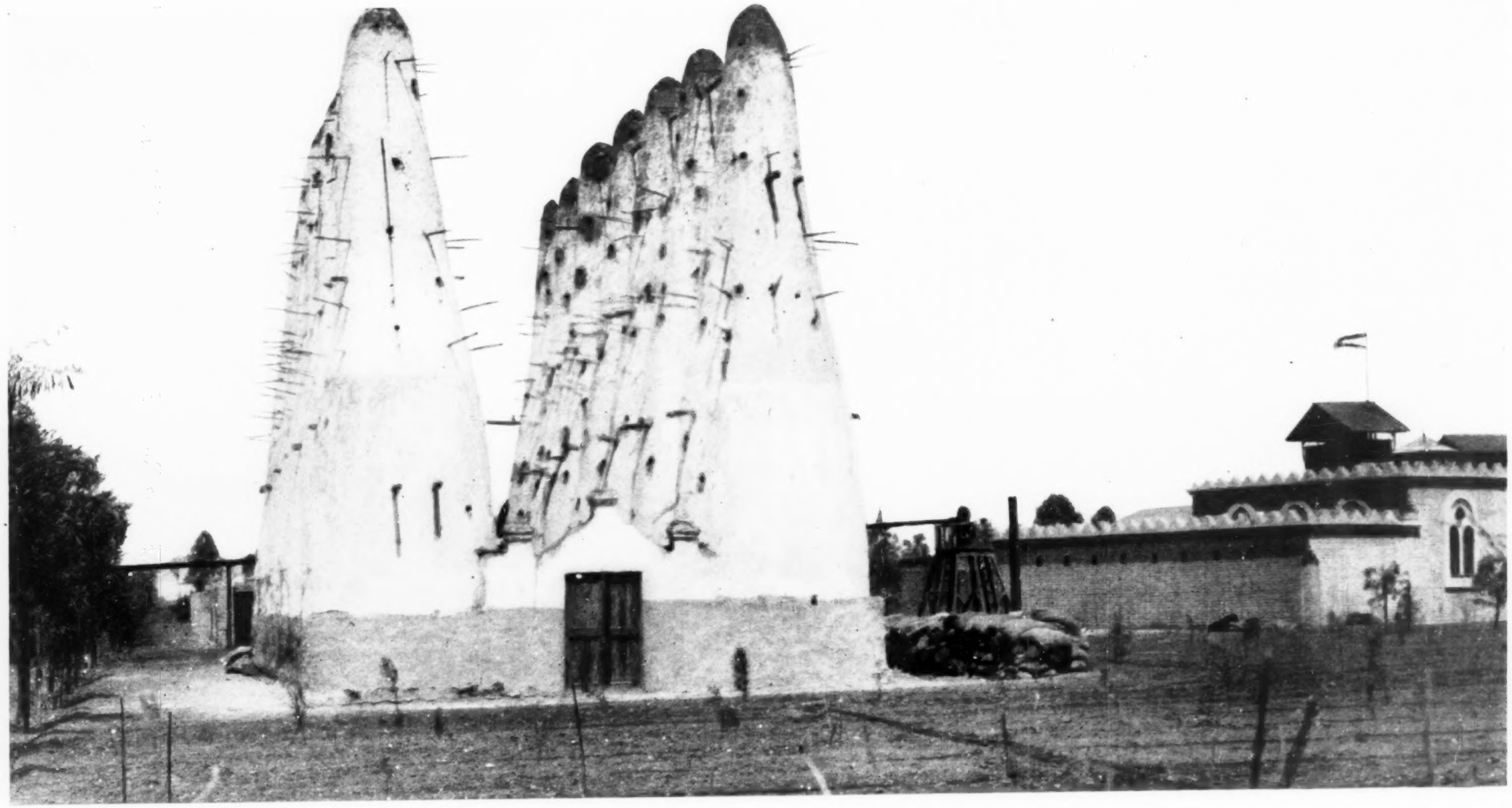
PIGEON BREEDING IN EGYPT.



Pigeon-breeding is an important industry in Egypt, and nowhere is it carried on more systematically than on the Beyerle estate, whose "pigeonry" is here shown. It consists of fourteen towers, each of which is made from 1,200 clay jars, laid in tiers with their openings inward. This arrangement makes it extremely easy to collect the manure, which is almost as valuable a product as the squabs. Mr. Beyerle started with 250 pairs of semi-wild pigeons, which he considered to be more fecund than the domestic breeds, and in a few years had 8,000 pairs in these towers, which, in addition to squabs, produced nearly 250 bushels of guano a year. Photograph by David Fairchild. (Frontispiece.)

BRIGHAM YOUNG

AN ILLUSTRATION OF PREPOTENCY

IT IS an axiom of heredity that the child inherits equally from his two parents; yet every observant person realizes that this is merely a general law, of a statistical nature, and that it does not always hold good in individual cases.

Sometimes one parent contributes much more than the other, as far as distinguishable characters are concerned. We then say that that parent is prepotent.

The idea of prepotency is particularly familiar to breeders of livestock, but few of them can explain it clearly, and the professional geneticist has so far met with little better success. It remains one of the most obscure things in the study of heredity, and some of the most plausible explanations of it are so hypothetical that it is almost impossible that their correctness should ever be proved.

But of the existence of the fact, no one can doubt. In the human species, every one can cite instances where all the children of a family "take" strongly after their father, or their mother, as the case may be. But never, perhaps, was the phenomenon of prepotency more graphically shown in man than in the accompanying photograph of eleven daughters of Brigham Young, by eight different wives.

"How different their mothers were," writes a member of this association who is well acquainted with the family. "But all the daughters are distinctly 'Youngs' in feature, voice, appearance and temperament. All are musical. All are amiable. All are adaptable, genuine, sincere, temperamental yet reasonable, and are good mimics. All are warm-hearted, generous, excellent cooks and housewives, and have the reputation of being attractive, magnetic and sympathetic. None is great as their father was great, but all are Youngs."

While many of these characteristics might be ascribed to similarity in training, one can hardly credit education with having influenced the shape of the mouth and nose. These features, however, in the daughters almost without exception, bear a very close resemblance to the corresponding features of the father. Certainly the strong, firm mouth of Brigham Young is reproduced in a most striking way. In general, it will probably be agreed that these children of a single father and eight different mothers show as much resemblance to each other as one often finds in the children of one father and mother.

MAJOR POND'S EXPERIENCE

An amusing incident connected with the likeness, which is so marked in Brigham Young's descendants, was that told very frequently by Major James B. Pond. He was always convinced that he could tell a descendant of Brigham Young, especially the girls, whenever he saw one and as an illustration he would tell of a certain time when he and a friend were walking on the streets of Seattle and he saw two young girls coming towards them.

Said Major: "Those girls are Brigham Young's daughters."

"Nonsense," replied his companion.

"Yes, they are," persisted the Major. "Will you wager with me?" he added.

"Yes," said his friend; "I will bet you $25 that they are not."

"Done," cried the Major.

As they met the girls the Major lifted his hat and said in his own courteous way: "Excuse me; this is a long way from Utah, but are you daughters of Brigham Young?"

The girls laughed and replied: "We are his granddaughters, through his eldest son, Brigham; but how did you know that?" The Major had earned his $25. People in Utah say that the

Photograph by Burton Holmes. Produced nearly 250 bushels of guano a year. Photo to squabs, produ

BRIGHAM YOUNG

He was of old Puritan stock, and although not all his ancestors have been traced, it is believed that he was of exclusively English descent—a belief that is borne out by his appearance. The first ancestor of record in America is William Young, who appeared in Boston and New Hampshire in 1721; but after him the Young family lived in Hopkinton, Mass. This photograph, taken only a few years before the death of Mr. Young, is considered by his family to be the best existent likeness of him. (Fig. 2.)

ELEVEN DAUGHTERS OF BRIGHAM YOUNG BY EIGHT DIFFERENT MOTHERS

Although coming from eight different mothers, the eleven daughters of Brigham Young shown above all have to a remarkable degree the facial traits of their father. The individuals shown are as follows (reading from left to right):

Top Row.—(1) Mrs. Myra Young-Rossiter, daughter of Lucy Deeker, who was dark, short, and very stout, a woman of "American Dutch" family; (2) Mrs. Josephine Young-Young, daughter of Emily Partridge, who was tall, slender, and of dark complexion, a Yankee; (3) Mrs. Susa Young-Gates, daughter of Lucy Bigelow, of Massachusetts; (4) Mrs. Phoebe Young-Beatie, daughter of Clara Chase, of the New York Ross family.

Middle Row.—(1) Mrs. Zina Young-Card, daughter of Zina D. Huntington, thin, and with prominent features, a Yankee; (2) Mrs. Emily Young-Clawson, daughter of Emily Partridge, Yankee, and a full sister of No. 2 in the top row; (3) Mrs. Luna Young-Thatcher, daughter of Mary Ann Angel, a Yankee; (4) Mrs. Maria Young-Dougall, full sister of No. 4 in the top row.

Bottom Row.—(1) Mrs. Ruth Young-Healy, daughter of Emmeline Free, a Yankee; (2) Mrs. Clarissa Young-Spencer, full sister to Myra, who is shown in the upper left-hand corner of the photograph; (3) Mrs. Janet Young-Easton, Daughter of Clara Deeker, also dark, very short, and stout, who was a sister of Lucy Deeker.

From a photograph furnished by Mrs. Susa Young-Gates, Salt Lake City, Utah. (Fig. 1.)

truth holds pretty good even to the latest generation, especially with the girls.

Brigham Young, who was born in Vermont in 1801, was the second president of the Church of Jesus Christ of Latter-Day Saints, and in the opinion of all its members was second only to its founder, the Prophet Joseph Smith, as an organizer and statesman. He led the people to Utah and governed them for more than forty years, until his death in 1877. In accordance with the early doctrine of his church, he had nineteen wives, ten of whom were mothers of his children. The others were widows to whom he gave a home and protection.

If the children of these different wives had inherited equally from their mother and father, there would have been a considerable diversity among them. Why is it that there is so little variation among them; why is it that the father "stamped his impress" on them so uniformly?

When we answer that it is evidently a case of prepotency of the father, we only postpone the real explanation one step further; for prepotency is a term that probably covers half a dozen different things. It often results from consanguineous marriage, but there is no evidence that such matings occurred in the ancestry of Brigham Young. It may also be promoted by assortative mating—"like with like"—and it is possible that marriages of that sort had taken place in the Young family, although the data extant do not suffice to make this point plain. It may also be due, according to present ideas, to a mere chance presence of a large number of dominant traits in one individual.

VALUE OF PREPOTENCY

Whatever its origin, prepotency is a factor of great importance to the geneticist, and the ability to control it and depend on it would be of great value to the science. This is as true of eugenics as of any other branch of genetics; for it is obvious that if we could establish stocks highly prepotent in some desirable character, it would be distinctly to the advantage of the race.

The subject of prepotency, therefore, deserves careful investigation by the eugenicist, and for reasons stated above it appears to the writer that no material available offers such advantages as do the genealogies of the Mormon families. Aside from the fundamental advantage of offering data about the offspring of a single husband and several wives, it has the further important element of fullness and accuracy, for the Mormons are among the most industrious and careful of genealogists. As it is for them a duty to work for the eternal happiness of one's ancestors, and as these ancestors must be known, if intercession is to be made for them, it results that every Mormon takes a practical interest in genealogy, and among the women of the church particularly, familiarity with genealogical methods is probably more widespread than among any other class of people in the United States.

The research worker, therefore, finds ready to hand among the Latter-Day Saints a large body of material of extraordinary value, which has as yet scarcely been touched for the purposes of biological research. It seems probable that the proper use of this material would advance research in human heredity more rapidly than will any other American genealogical data available to the student; and among the important problems on which light would be thrown is certainly the problem of prepotency, which is so strikingly illustrated in the accompanying photograph of Brigham Young and his children.

THE PERSIAN WALNUT

A Typical Problem in Tree Breeding—Great Improvement in the Past Due to Unconscious Selection and Chance Hybridization—Much Greater Progress Possible in Future, Through Intelligent Methods.

J. RUSSELL SMITH

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ONE of the most significant statements I know in connection with the whole matter of agricultural extension on the production side is the following from C. S. Sargent, in connection with the Persian[1] walnut (*Juglans regia*).

> "The nut of the wild tree is small, with a thick hard shell, and small kernel, and is scarcely edible, but centuries of cultivation and careful selection have produced a number of forms with variously shaped thin shells, which are propagated by grafting and budding." (Silva, Vol. VII, p. 115.)

To persons familiar with the big, sweet, nutritious nuts now so common in the world's market, it is indeed difficult to believe this statement as to their original unpromising condition. This improvement appears to have come by chance breeding which has given a splendid tree crop for the Mediterranean climate where it seems to have originated, and it has also given a most stimulating object lesson of the means by which we may duplicate the process in walnuts of several species and *for scores of other trees* that are not now crops at all. The method by which the magnificent Franquette or Mayette walnuts have come out of the mean parentage described by Sargent is *probably* as follows:

Centuries ago, perhaps dozens of centuries ago, people in southern Europe and western Asia carried home the seed of wild walnut trees from the woods as we do now with black walnuts, chestnuts, hickories, hazels and other wild nuts. They planted of the best in their gardens. This may properly be called a selection of one in hundreds. Of the resulting seedling most were certainly poor trees from the horticultural standpoint, but one out of a hundred was likely to be good, perhaps better than the parent. From what we know of human nature wrestling with the problem of stomach-filling, this best tree became the parent of the next generation of seedling walnuts in that valley or the next valley—again a selection of one in a hundred. We now have the hundredth tree from the hundredth tree. This may easily have been repeated ten, twenty, or even fifty or more times. The best seedling walnuts of today thus represent the selection from among a vast number of seedlings.

SELECTION IN BOTH SEXES

But hold—this is not all. These seedlings have not been yielded by extra good females fertilized by *average* males. The collections of seedlings from selected seed have often given chances for the crossing of *two selected strains*. To all intents and purposes we have had practical walnut breeding going on—but

[1] The name "walnut" means merely "the foreign nut," and was given by the early English because the nut came from abroad. The name "English walnut," under which the Persian walnut passes commercially in America, is due to the fac tthat many of the nuts were transshipped to this country in England; but as it is an absolute misnomer, the name "Persian walnut" is now generally used among growers.

we have been going it blind. Now we can go at it with our eyes open. If by chance we have in unknown centuries turned a small nut "with a thick hard shell and small kernel, scarcely edible" into the splendid one for which we pay 25 or 30 cents per pound, what may we do if we use our known powers of cross breeding and hybridizing? Is it not reasonable for us now to expect to be able to produce as great changes in twenty-five or fifty years as chance has done for us in twenty-five or fifty centuries?

The Persian walnut, this golden gift of chance breeding, is a grossly neglected agent.

This nut is great in its economic significance, for the future, and considering its possibilities it is equally great in its agricultural insignificance in the present. Its food value places it very high among foods, because of its high percentage of meat in comparison to waste, and its combination of food elements, furnishing as it does the costly protein and the much coveted fat. Further than this, the tree produces one of the most valuable of woods.

In operation it shows up as a veritable engine of food production, a single good tree in France commonly yielding as many pounds of human food per year as is given by the meat produced by an acre of pasture in England. Of the two foods the walnut is more nutritious by the ratio of 2 to 1. Grafted trees of the Mayette and other varieties scattered about the fields of France have been making these heavy yields for many decades.

The range of the tree serves to emphasize the unrealized possibilities. The Persian walnut with these wonderful qualities of heavy yield of rich food and good wood is at home in a wide belt which encircles the globe in both hemispheres. The tree is actually found all through the Mediterranean region of Europe, in Asia Minor, Central Asia, China, and Japan, in Pacific America and in the Eastern United States from Georgia to Ontario. It also grows in the South Temperate zone. It has been known from ancient times, and yet it has been developed as a crop only in a few areas, as in Southern France, Italy (near Naples), California (chiefly near Los Angeles), and the Orient. I doubt if there is a 10-acre orchard of grafted walnut trees under one management in all Europe. I have been in all the leading districts and found none so large, merely little patches and scattered trees.

IN EASTERN AMERICA

In the eastern United States there have been scattered trees producing good crops for many years. Trees of local repute have recently been reported from Ontario, Michigan, New York, New Jersey, Pennsylvania, Maryland and Georgia. Some of them are of great size and over a century old.[2] Some of these trees are reported to be practically annual bearers, yet thus far the nut has strangely failed in becoming the basis of a regular crop in the eastern United States. This fact has had two causes, chief of which is the past dependence upon seedlings, which are indefinitely variable, and in the eastern United States mostly worthless, because of unacclimated seed; and its great susceptibility to frost, due to its early blossoming. These causes have resulted in the failure of numerous commercial attempts dependent upon seedlings.

As an instance of this I will cite my own ill-guided experience. In 1896 I planted two acres in northern Virginia of the best seedling Persian walnut trees I could then secure from a New Jersey nursery. They were 3 to 4 feet high. The next year they were 2½ feet high, the next year they were 1½ feet high. Then they began gradually to disappear. The last one lingered until 1912, when a temperature of 25° F. snuffed out its worthless and despairing life. It grew in a magnificent, rich spot and attained the height of 9 feet. Most of the new growth winter-killed annually and it never bore a nut. There were no grafted trees to be had at that time and

[2] See reports of Northern Nut Growers' Association, 1912-1913, Dr. W. C. Deming, Secretary, Georgetown, Conn.

it was reported, even I believe by the United States Government, and believed everywhere, that they could not be grafted or budded.

This benighted condition of a possible industry is hard to believe when we stop to think of the fact that the grafting and budding of these trees has been going steadily on in the vicinity of Grenoble, France, for generations. There lived that pioneer nut culturist, Mayette, who propagated the variety that bears his name. In this district top worked trees have been for sale almost any year since before steamships started across the Atlantic. And yet so far as I know this might just as well have been in the moon for all the good it did us until California started the walnut industry. The grafted Mayettes of the stock of Grenoble are now proving hardy in Pennsylvania and Connecticut and if the kind used in the Grenoble district (Persian on Persian) had proved unsatisfactory there apparently would have been little difficulty in getting Grenoble nurserymen to raise American black for us and to graft it to anything we favored. Fortunately, however, we do not have to go into any such heroics now to get the trees.

GRAFTING THE TREES

We now know how to graft and bud this tree right here in the eastern United States and put it upon the more vigorous roots of the native black walnut. As to the technique of this newly-won process, there are four points for the ordinary apple or pear grafter to keep in mind, and the same also apply to the grafting of the hickory genus which offers, in almost every respect, problems like those of the walnut genus. These four points are: (1) Keep the cions from drying out by waxing entirely or by binding a paper bag over the stock and cion; (2) Do not split the pithy cions, avoid this by trimming wedge grafts so that one of the cuts goes clear across the pith; or use the slip bark method which has all the cut on one side; (3) Graft or bud when the tree is in rapid growth; (4) Use well ripened, well developed wood cut early in the winter. Two-year-old wood seems to be better than one-year-old wood and California grown wood has shown itself superior to eastern grown wood. It is quite possible that we will shortly begin to send cions of desirable eastern trees to California to have budding and grafting wood grown for eastern use.

In budding, the patch bud and wing bud methods are the only ones that have shown themselves worth while. The experience of the years 1914–1915 seems to indicate that this budding may be done early in the spring with wood from cold storage and forced into immediate growth by cutting off other growth. For photographs and details important to the experimenter see bulletin on the walnut by United States Department of Agriculture and the reports of the Northern Nut Growers Association, W. C. Deming, Secretary Georgetown, Connecticut. I am having lots of fun from the two dozen nut trees I have grafted and budded.

SELECTION OF PARENTS

The discovery of these new arts of propagation serves instantly and acutely to emphasize the question, What *parent trees* shall be used in propagation? Only a fraction of the eastern trees have been examined carefully, and it is perhaps true that none has yet been found in the Eastern United States with fruit of the high quality of the best European varieties. In addition to the great variation in the quality of nuts, there is great variation in the adjustment of the trees to the climate. This makes a careful survey of the existing and widely scattered thousands of Persian walnut trees in the United States a very promising prospect. Here is also a problem in *tree breeding*, rich with possibilities. The great variation within the species and the easy and wide range of its hybridization with other species would indicate that it has great possibilities in the hands of the plant breeder.

An interesting example of the case of its hybridization is furnished by a New Jersey farmer near Camden. He has three or four fine and very productive Persian walnut trees. He was so pleased

THE ORIGIN OF A VALUABLE VARIETY

This Persian walnut tree is growing on Pequea Creek in Lancaster County, Pa., and was discovered some years ago by a man interested in nut-growing in the Eastern United States, who realized that this tree was worthy of propagation. It is supposed to be fifty years old, and bears two or three bushels of early-maturing nuts in a good year. Nothing is known of its parentage, but it is undoubtedly a seedling, which happens to bear nuts of good quality, and to stand a great deal of cold weather. It was made the foundation of a new variety, which was given the name of Nebo, and which is now being disseminated and is helping to make the culture of the Persian walnut possible in regions where it was formerly supposed that the climate was unsuitable. Photograph from the U. S. Department of Agriculture. (Fig. 3.)

with them that he planted one hundred more, seedlings from a nursery, foolishly thinking them all much alike. The new trees grew finely, showing the Persian type of foliage. When they bore, it was such a collection of long rough nuts of evident butternut (*Juglans cinerea*) paternity that the farmer dug up all of the trees but one, which bears a nut of apparent hybrid form and little value.

Experiments of Dr. Robert T. Morris and others have shown that there is great freedom of hybridization between the various species of walnut. Some hybridization is possible between the walnuts and hickories. So common is the cross between the Persian and the Black in California that it is a recognized kind called Royal, distinguished as are many hybrids for astounding vigor of growth. This is offset by a poor yielding power but Professor Smith, of the University of California, reports *one* (see bulletin on walnut blight, 1912) that is a good bearer. That *one* tree is exceedingly significant. It would seem to indicate that others like it can be produced—fruitful and growing with the fury of a weed. This is merely one of the many breeding problems which the walnut alone holds out to us now that we know how to breed plants.

A MARYLAND SPECIMEN

A peculiarly promising tree as a breeding parent, is one that has been found in Maryland about eighteen miles north of Washington, D. C. If the nut had a little less bitter on its skin, the tree would be an almost ideal parent. It is reported to have borne twelve or thirteen consecutive crops. This is unusual for any fruiting tree. Rumors to the contrary, consecutive cropping of fruit and nut trees is not common except in the form of a heavy and a light crop alternating. Unfortunately I cannot give exact measurements for the yield of this Maryland tree. Its regular record is probably due in large part to its late habit of spring growth. Whereas most of the Persian walnuts send out their leaves with the earliest approaches of spring and lose their blossoms and often their foliage and twigs with frost, as does the apricot, this tree remains dormant until June, then grows with great rapidity and matures its crop. In Grenoble, France, I saw on the 10th of June, 1913, when farmers were making hay, some Persian walnut trees just showing the first green of their buds at the same time that cherries were ripe on an adjacent tree. I should have passed these trees by except that I asked my companion, Vice Consul Murton, a master of the local walnut situation, why the leafless trees had died. Although permitted to live, these trees were not particularly prized by the French walnut growers, because they were reported to bear scanty crops, although the nuts were reported of satisfactory quality. The bringing together of these two late strains, one of good bearing habit and fair quality, the other of excellent quality and both of wonderful frost resisting ability would seem to have great promise as a breeding experiment.

I called these facts to the attention of E. R. Lake, of the Pomological staff of the United States Department of Agriculture, and asked him who in the United States was in a position to conduct these experiments. After a moment's pause he said, "I guess you will have to go to J. W. Killen, of Felton, Delaware." I happen to know that Mr. Killen is a farmer of an experimental turn of mind, willing to work and sacrifice time and money for the advance of agricultural knowledge. I regard it as little short of lamentable that so great a problem as the breeding of a new tree crop of the importance and promise of the Persian walnut should, in the United States of America, be dependent wholly upon the unpaid and unsupported enthusiasm of a private individual. We need at once a thorough search for the best among the hundreds of possible parent trees in the East. Mr. Fagan, of Penn State College, made such a survey of his state in the summer of 1915 and found about 5,000 Persian walnut trees which are now under observation. They need testing out with regard to their behavior under cultivation, their resistance to the Cali-

fornia walnut blight, and numerous experiments in cross breeding and hybridization should be made to develop the good parent trees which we now have reason to believe can be produced by the breeding from many of the promising trees already known to us.

THE PROBLEM OF TREE CROPS

If chance hybridization and selection in the past has brought the worthless wild tree described by Sargent to the present perfection of the commercial Persian walnut, we certainly have great reason to anticipate large results from systematic hybridization if we can focus the resources of constructive science in that direction.

The Persian walnut is but a type in the whole tree crop question. Its typical aspects may be summarized as follows:

1. As a crop producer it is almost worthless in its wild state.
2. Some trees usually widely scattered are much superior to the average and worthy of propagation.
3. Cross-bred strains from selected rare trees are much superior to any wild tree (such have been produced in the gardens of Mediterranean lands).
4. The possibilities of better varieties by hybridization have merely been glimpsed, not realized, and demand immediate work.

The plant kingdom has never been systematically searched for useful plants. This is particularly true of trees, from which we have held back because of the time element; yet there is little doubt that forty or fifty species of wild trees are quite as promising of a good agricultural crop as was the wild walnut described by Sargent. By selection, propagation, cross-breeding and hybridization, each of the fifty or more can probably, like the walnut, be made into a valuable crop producing food for men, and what is more important, agriculturally, food for the beasts, if the problem is systematically handled. This field of endeavor also promises one of the most potent cures for the erosion problem. The hillside whose soil is pinned to the bed rock by the interlacing roots of crop yielding trees will not erode. It will stay and pay.

Breeding Native Grapes

Valuable work on self-sterility has been done at the North Carolina Experiment Station, principally with native grapes, but to a less extent with persimmons, blackberries and dewberries. It is found that the latter berries are in some cases self-sterile and in some cases self-fertile; grapes of the muscadine type (*Vitis rotundifolia*), however, have proved to be self-sterile in almost every instance. It is therefore necessary that the grower of such grapes should plant enough male vines to furnish pollen; and it has been found that there are two distinct wild types of male vine, the commoner one producing grapes that, when further propagated by seed, yield dark-colored fruit, while a rarer type, when perpetuated, yields light-colored fruit. All scuppernong grapes of the immediate generation are light colored. By the growth of several thousand hybrid seedlings, an effort is being made to find whether such characters as color of berry, persistance of holding fruit and size of fruit and size of fruit clusters are transmitted, and if so, by what laws.

In this connection it will be of interest to mention that the United States Department of Agriculture is engaged in breeding a strain of muscadine grapes with perfect flowers, starting with a single individual of this character which was found among a lot of seedlings. The project promises to be wholly successful, and will make the production of these grapes much more profitable. Hybridization is also being used to produce varieties of grapes that will combine the vigor and disease-resistance of the *Vitis rotundifolia* and its large berries, with the hardiness and large clusters of the northeastern United States species (*Vitis labrusca*, etc.).

PROBLEMS IN WALNUT BREEDING

The Industry in California Being Transformed Through Propagation of Grafted Trees—Walnut Blight and the Variability of the Present Groves—the Ideal Commercial Nut[1]

L. D. BATCHELOR
University of California Citrus Experiment Station, Riverside, Cal.

THE walnut industry of California is just entering a transition period, from the planting of seedling groves to the establishment of plantings composed of grafted trees. Just as other seedling fruit trees, such as the orange, apple, peach, almond, etc., have been eliminated, so, too, the seedling walnut groves of California seem doomed to be replaced by clonal varieties. In many ways this industry is as much in its infancy as the apple industry of New York was sixty-five years ago, when varieties first began to be propagated in a commercial way by grafting and budding. This readjustment in the walnut industry is well started, and although it is likely to be gradual in its evolution, and wisely so, the change seems nevertheless certain. There are but a very few seedling trees for sale at the present time by the progressive nurseries, and in fact only a very few such trees have been set out in groves during the past four or five years. This demand for a grafted tree has been brought about largely by the wide range of variation in walnut seedlings, as regards their productivity, commercial value, season of harvest and ability to resist the walnut blight.

With this very recent propagation of the walnut by grafting, which has extended over only ten or twelve years, it is reasonable to expect that the majority of the varieties thus propagated so early in the development of this industry are only partly suited to the needs of the walnut grower. The nuts from many of these grafted varieties fall considerably short of the commercial standard for high-grade walnuts. Some of the heaviest-bearing sorts, such as the Chase, Prolific and El Monte, produce nuts which cannot be sold in the very best grade of the commercial product. On the other hand the Placentia, which produces the most nearly ideal commercial nut, is not a heavy-producing variety, especially in the northern walnut sections, and is quite as susceptible to walnut blight as the average seedling tree. Again, the Eureka variety, which seems successfully to avoid the walnut blight during many seasons by its lateness in coming into bloom, is a very moderate yielding sort in the southern sections. The above examples are only a few of many which might be cited to show the shortcomings of most of the varieties of walnuts now being propagated.

MANY VARIETIES NEEDED

The wide range of climatic and soil conditions makes the eventual propagation of quite a large number of varieties inevitable. While the coast regions are bathed in fog nearly every morning during the growing season, the inland valleys experience an extremely dry climate with high maximum temperatures. Walnuts are being grown at the present time on soil types varying from the extremes of sand to heavy clay loams. Many of the future varieties must be especially adapted to some one of these particular environments if they are to withstand the test of time.

Many of the present seedling groves are of uncertain origin and represent greatly varying values. No doubt some

[1] Read before the twelfth annual meeting of the American Genetic Association, at Berkeley, Cal., August 5, 1915.

of these groves are the progeny of especially selected trees known to have considerable merit. On the other hand, it is very apparent that many of them are the result of a great demand for seedling trees when this industry was in its infancy twenty or thirty years ago. At that time great quantities of walnuts were planted without due regard for their parentage. Again, there is a wide range of variability among the individual trees of any grove, as variations in type of tree, blooming season, character of foliage, resistance to disease, productivity and character of the nuts.

Type of Tree.—The tree types vary from the upright sturdy individual to the more or less spreading, weeping types, which droop nearly to the ground under the burden of their crop. The upright, vigorous growing type is well exemplified in the Eureka. On the other hand such varieties as the Prolific have a spreading, bushy habit, and an almost semi-dwarfness characterizes their growth.

Blooming Season.—It is not unusual to find the blooming season in an ordinary seedling grove extending over a period of from a month to six weeks. A few individual trees leaf out and blossom with the first signs of spring. Then quite the larger part of the grove comes out in full leaf, while there are frequently trees which are still bare after the nuts on the early individuals are of the size of a marble. This variation in the blooming season has considerable economic importance in relation to the harvesting and marketing of the nuts as well as the avoidance of diseases and frost which may be more prevalent during certain periods in the spring.

MANY TREES UNPROFITABLE

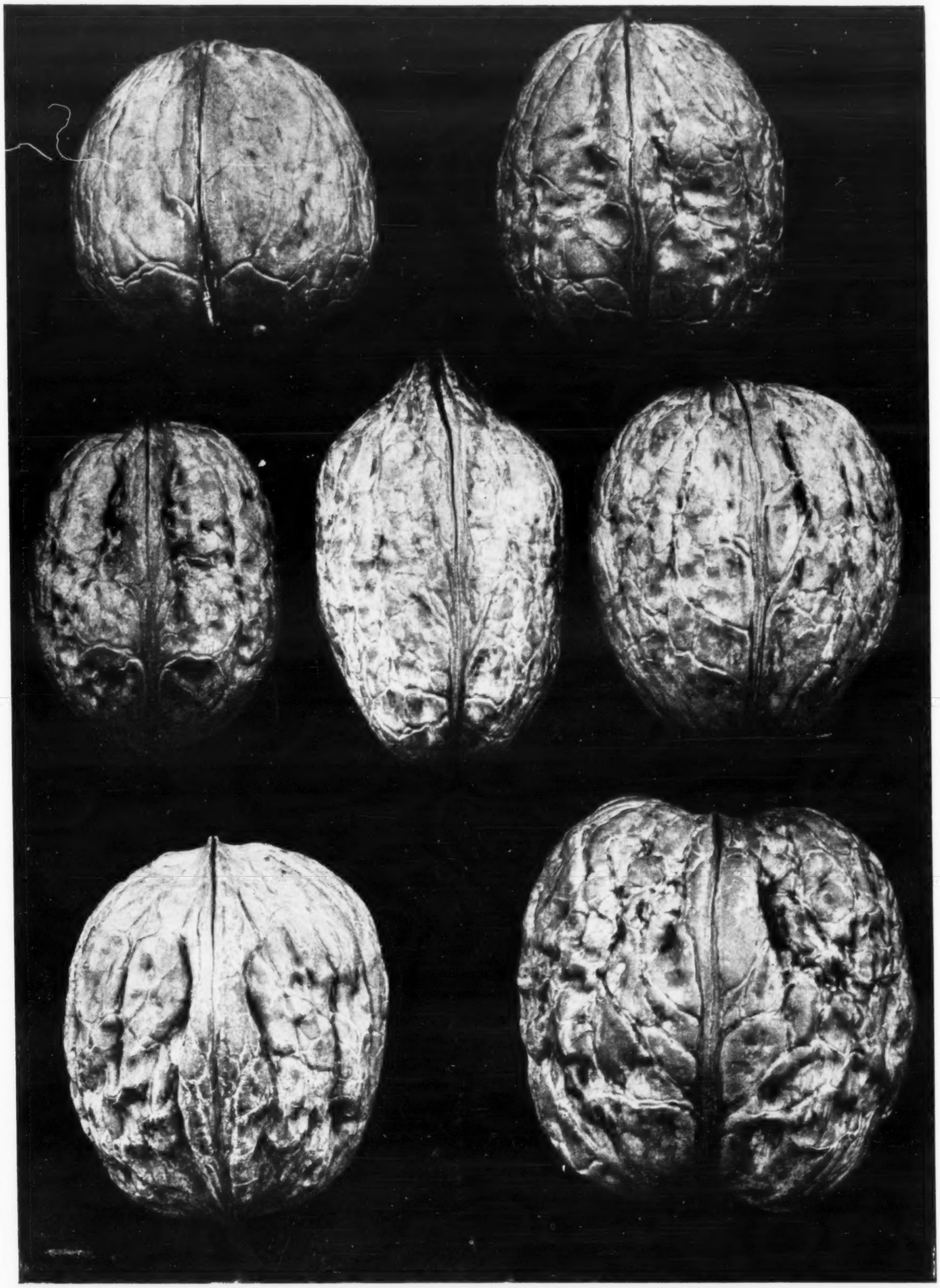
Variation in Productivity.—Some of the old experienced walnut growers feel that 25% of their seedling trees are unprofitable, another 25% are barely paying expenses, and that the profit is really derived from about 50% of the trees. The variations in seedling trees is well shown by Smith[2] in summarizing the results of certain fertilizer tests; he found that twenty trees in a given row varied in productivity as follows: Number of pounds produced by each tree, 1, 16, 45, 10, 21, 97, 20, 8, 26, 0, 16, 1, 18, 13, 10, 21, 2, 31, 7, 14. This is only a fair example of the variation in the large majority of seedling groves. The above figures are from a young grove and should not be considered as typical of the total production for twenty mature walnut trees.

Foliage Characters.—The character of the foliage varies from the broad-leaved types, in which case the foliage somewhat resembles that of the horse-chestnut, to the narrow-leaved varieties whose leaves have a tendency to curl up like the foliage of the Winesap apple. The broad-leaved types are much more densely foliated and this factor has considerable bearing on the problems of sun-scald on the twigs and trunks of the tree and the exposure of the nuts to this malady. For this reason, the densely foliated varieties may prove best adapted to the inland valleys, where the difficulties of sun-scald are most prevalent. The more sparsely foliated sorts often appear to have less blight on the nuts and leaves, because of their exposure to the sunshine.

Disease Resistance.—Probably one of the most important limiting factors to walnut production in California, and especially in the older walnut sections, is the bacterial disease commonly known as walnut blight. The inroads of this disease have caused a very heavy dropping of the nuts during many seasons of the past, and although a great deal of time and scientific effort have been devoted to the control of this trouble, there is no known means for the prevention of walnut blight at the present time.

The great variation among seedling trees in regard to their susceptibility to blight is indeed a hopeful sign for the eventual production of varieties which will more or less resist this malady. Among 105 trees in an orchard under observation in Orange County, the percentage of diseased nuts on the individual trees before any dropping had

[2] Calif. Bull. 231, p. 187, 1912.



COMMON TYPES OF WALNUT IN CALIFORNIA

The Persian (commonly called English) walnut is widely grown in California, but as the early groves were all planted from seed, there are now a great many different types of nuts produced. This illustration shows the wide variation among these types. Efforts are now being made to organize the industry on a sounder base, by eliminating the worthless types, and introducing new ones which shall combine as many good points as possible. (Fig. 4.)

YOUNG WALNUTS AFFLICTED WITH BLIGHT

The walnut industry of California has been seriously threatened by a bacterial disease, against which no remedy has yet been found. It has been discovered, however, that great differences exist among individual trees, in their resistance to this infection; and by propagating the most resistant trees, it is believed that groves can be created which will be practically immune to the disease. (Fig. 5.)

taken place, ranged from 6% to 95%, while the average amounted to 47.4%. These percentages are not given with the idea of expressing the exact amount of injury caused by this disease, as many nuts which are slightly blighted remain on the tree and may yield a commercial product. In calculating the extent of this disease, every nut which was blighted in the least was counted as diseased, and thus the comparisons are thought to be a fair indication of the variation of the blight on the individual trees, but not necessarily an estimate of the damage to the grove. From our present knowledge it is very apparent that the disease resistance of individual trees varies considerably from year to year and under different soil and climatic conditions. The thorough testing of resistant varieties will require considerable time.

Nut Characters.—The nuts are as variable as the trees themselves, not only in the exterior appearance but in the character of the meats as well. The ideal commercial nut should be of medium size, as 1⅛ to 1½ inches in diameter, of a regular oval form somewhat elongated, smooth surface, and light brown color, and uniform for these characters. The cracking quality of the nuts is quite as important as their exterior appearance. The nuts should be well sealed so they will not crack open in shipping. The shells should be thin but strong so the nut may be easily opened and the whole meat taken out intact. The pellicle should be light tan colored or silvery brown with a glossy waxed appearance attractive to the eye. The meat should be smooth, filled uniformly throughout the nut, averaging 50% or more of the total weight, and with a mild, pleasant

flavor free from any astringency. The shells vary from extremely rough and unattractive specimens to smooth commercial types, as the Placentia, while the color of the meats varies from dark brown to nearly white, and so on through the other characteristics mentioned.

In the selection of varieties, the walnut breeder is exceptionally favored by the occurrence of large areas of seedling trees. According to the 1910 census, there were in the neighborhood of one and a quarter million seedling trees growing in California. With this almost unlimited material for selective use, it seems indeed reasonable that many varieties will be selected in the future, which are better adapted to the demands of the industry than some of the walnuts now being propagated. By means of hybridizing methods, it is also hoped that some of the desirable unit characters of the sorts now in cultivation may be re-combined into more nearly ideal varieties for future generations.

Very little is known at present concerning the correlation of certain desirable or undesirable characters of the walnut. Work is under way at present by the Citrus Experiment Station in an endeavor to ascertain these relationships.

The fact that walnut breeding is necessarily a long-termed, expensive problem has made it rather unattractive to the practical breeders. Such work will depend largely upon public institutions for its support.

Plant Breeding at Cornell University

The plant breeding work at the Cornell University (New York) Experiment Station has given results of both economic and fundamental importance. Among the former are to be noted the production of high-yielding strains of cereals, potatoes, timothies, and so forth. For example, improved strains of oats have been found to yield from 9 to 14 bushels per acre more than the variety from which they were isolated. Two strains of dent corn mature about two weeks earlier than the variety from which they were produced and at the same time outyield somewhat the original variety. The superiority of some of the selected strains of timothy over ordinary timothy has been demonstrated. Hill selection of potatoes has been shown to be an effective method of producing high-yielding strains.

Of the more important fundamental results obtained from the Cornell Station's breeding work may be mentioned the following: Bud variation has been found to occur with no inconsiderable frequency in potatoes and has been demonstrated in clonally-propagated timothies. Results of importance not yet formulated for publication have been obtained through studies of seasonal and place variation in daisies, through selection within pure lines of cereals, through hybridization of oat and wheat varieties, and the like. Extensive studies in color inheritance in phlox, morning-glory, beans, corn, and so forth, are being prosecuted, the latter having been recently transferred from the Nebraska Station. Statistical studies of variation also constitute an important part of the plant breeding work at Cornell.

Altering the Galloway Breed of Cattle

At the Alaska experiment stations, Special Agent C. C. Georgeson writes: "We have made a beginning in the development of an all-purpose cow from the Galloway. Something more is needed in Alaska than the beef qualities, which are so characteristic of the Galloway. The Alaska settler wants a cow that will give milk, as well as produce beef and at the same time be hardy enough to withstand the climate. We expect to reach results by proper mating and selection. It is not contemplated at the present time to go outside of the breed to secure milking qualities, though, undoubtedly, results could be reached more quickly by crossing with some other breed, thereby sacrificing the purity of the stock. The Brown Swiss might make a good cross with the Galloway."

$1000 FOR DATA ON HEREDITY

MOST students of heredity today believe that the results of use and disuse are not inherited; that work done by the parent will not affect the inborn character of the offspring; in short, that "acquired characters" are not transmitted.

C. L. Redfield, a Chicago engineer, holds the opposite view. So strongly does he believe that the general opinion of biologists on this point is incorrect that he has offered the American Genetic Association $1,000 for evidence on the subject. This is to cover data on five points.

1. He will pay $200 for evidence that any one of the two or three thousand intellectually great men or women of history is the product of an ancestry which represents, on the average, four generations to a century.

2. He will pay $200 for evidence that any one of the two or three hundred intellectually *very* great men or women of history is the product of an ancestry which represents, on the average, three generations to a century.

3. He will pay $200 for a case from livestock breeding, where the parents made acquirements below the standard, in respect to performance, and the offspring surpassed the parents.

4. He will pay $200 for a case where a decline in powers of the offspring failed to follow acquirements, in the parents, which were clearly and distinctly below the standard of performance of the breed.

5. He will pay $200 if it can be shown for any group of animals that the amount of improvement or decline in animal powers was not, as nearly as can be determined by actual measurements, exactly proportional to the amount of acquirement by ancestors above or below the normal or standard.

The last three items require full pedigrees for three generations with measurements applied, with a fair degree of accuracy, to each parent in the pedigree. Mr. Redfield's publications give numerous examples of how measurements are made and applied to three generations of ancestors. The comparison is to be between the final product and the ancestors three generations previously.

Approved securities to the amount of $1,000 have been deposited by Mr. Redfield with the treasurer of this Association.

The first two items enumerated above are extensions of a proposal which Mr. Redfield has been making through this association for nearly two years. The result of the first year of the offer were stated in the JOURNAL OF HEREDITY for February, 1915 (Vol. VI, p. 92); half a dozen pedigrees were sent in, but none of them met the requirements.

TWO PEDIGREES SUBMITTED

During the past year only two pedigrees of interest have been sent in. Marshall Nevers, of 113 Columbia Heights, Brooklyn, N. Y., has pointed out that the ancestry of William the Conqueror covers about 100 years in three generations, while Dr. Heinrich C. Keidel, instructor in the German department of Ohio State University, has submitted the pedigree of Frederick the Great, showing that he, too, comes in the three-generations-to-a-century class.

It appears that the council of this association must undertake the somewhat unpleasant task of declaring whether or not, in its opinion, the intellectual greatness of either William or Frederick is sufficient to entitle him to a place among the two or three hundred intellectually most eminent men and women of history. At Mr. Redfield's suggestion, the consideration of this point is postponed and these two contributions will be submitted under the new and larger offer, to be decided upon at the end of the present year.

In the meantime, it is the hope of the council that genealogists may be able to uncover other great men who are the

product of several generations of early marriage. Data on this subject and the others brought up by Mr. Redfield are of real value to the study of heredity entirely apart from Mr. Redfield's own interpretation of them.

The other three items in Mr. Redfield's new offer should be of particular interest to the students in agricultural colleges, who have access, in many cases, to the necessary records, and could easily investigate the question whether performers of great merit have been produced in any other way than that indicated by Mr. Redfield. It may be of interest to refer to earlier investigations on this subject, particularly that of F. S. Putney[1] with the dairy herd record of Missouri Agricultural College, and that of F. R. Marshall[2] with the records of American trotting horses. Both these investigations were undertaken for the purpose of testing Mr. Redfield's theory of heredity, and both failed to satisfy their authors that that theory is correct.

Mr. Redfield, however, does not consider these two investigations conclusive. But as many breeds of live stock offer ample data on the point of record of parents and offspring, there should be no difficulty, with the inducement of Mr. Redfield's money offers, in getting abundant evidence on the question of whether or not great performers can come from poor or undeveloped performers. As Mr. Redfield says, the facts are capable of reasonably exact measurements in what he calls dynamic units"—that is, in units of work performed by parents before reproducing.

Here is Mr. Redfield's communication to the JOURNAL OF HEREDITY, with the details of his new offer:

MR. REDFIELD'S STATEMENT

"In April, 1914, I offered a reward of $200 for evidence that any mentally superior human being was ever produced by rapid breeding. The offer was divided into two parts in such a way as to make the degree of superiority directly dependent upon the rate of breeding. Thus, $100 was to be paid for any intellectually superior person produced by breeding at the rate of four generations to the century, and another $100 for any very superior person produced at the rate of three generations to the century, or faster. The details of the offer were published in the JOURNAL OF HEREDITY for July, 1914.

"The original offer expired December 31, 1914, and was later extended to December 31, 1915. I am now renewing the offer for the year 1916, and at the same time I am doubling the amount of the reward offered. The offer now is $200 for any superior person produced at the rate of four generations to the century, and another $200 for any very superior person produced at the rate of three generations to the century.

"In the above offer, rate of breeding means age of parents at time of reproduction, and age of parents means the inheritance of acquired characters, and means nothing else. The age of a parent at the time of reproduction is the coefficient of a variable, and extending it over three or four generations necessarily involves inheritance.

"If an acquired character is to be inherited, the parent must make the acquirement first and get the offspring afterwards, not get the offspring first and make the acquirement afterwards. The age of parents is simply one factor in determining the amount of a parent's acquirement at the time of reproducing.

"In my various publications from 1902 to 1914 I have pointed out that acquirements are dynamic in character and may be measured in dynamical units. I have also pointed out that when it comes to questions of mental or physical power in animals there must be a certain standard amount of acquirement per generation before reproduction to maintain any species, breed or family of animals on a level—that is,

[1] Annual Reports of American Breeders' Association, Vol. VI, pp. 310–317. Washington, D. C., 1910.

[2] American Naturalist, January, 1909.

keep it from degenerating in its power capabilities. In *Dynamic Evolution*[3] I have given detailed explanations of how acquirements are measured, how the standard for any group of animals is determined, and how comparisons are made. Also some peculiarities of the manner in which acquirements are transmitted to succeeding generations.

THREE GENERATIONS REQUIRED

"I now make an additional money offer for contrary evidence bearing on this matter, the understanding being that measurements must be in dynamical units, must be reasonably accurate, and must extend over three generations of ancestors, or so much thereof as will leave no doubt whatever as to what the measurements for three generations will say.

"1. I have given detailed accounts of large numbers of cases in which improvement in mental and physical powers followed excess acquirements in previous generations. I will give $200 for any case in which improvement followed acquirements below the standard.

"2. I have given the details of many cases in which a decline in powers followed acquirements less than the standard. I will give a second $200 for any case in which a decline in powers failed to follow acquirements which were clearly and distinctly less than the standard.

"3. By taking large numbers of animals I have shown that the amount of improvement or decline in animal powers was, as nearly as could be determined by the measurements, exactly proportional to the amount of acquirement by ancestors above or below the normal or standard. I will give a third $200 if any group of animals is found for which this is not true.

"The aggregate of these offers is $1,000, and they extend to December 31, 1916. If the $1,000 is not captured it will not be because there is any lack of material from which the matter may be tested, or any difficulty in doing the necessary work. Published pedigrees and histories of men, horses, dogs and cattle furnish all of the evidence necessary for a complete investigation, and the mathematics involved is of the simplest kind.

"Men of great ability arise from common stock; many horses of the present day trot much faster than any horse was capable of trotting fifty years ago; cows frequently produce many more pounds of milk in seven days than was the utmost capability of any of their great-granddams, and dogs under tests in field trials show more 'class' than any of their ancestors. The claim is made that every case of this kind arose by the inheritance of excess development acquired before reproducing, and that it is impossible to increase the mental or physical powers of any kind of animal in any other way than by the inheritance of such acquirements. If any one can show the contrary he can capture my money.

DETAILS TO BE PUBLISHED

"The American Genetic Association, or its accredited representative, shall be judge in this matter, and if the money is captured the judge shall say to whom it shall be paid and how paid. It is expected, in case the money is captured, that the judge will publish his findings in the case, giving full details of the evidence upon which the decision is based.

"In this connection I will offer the following for consideration: According to the current theory of evolution, there was, some time in the past, a common ancestor for man and the higher apes. There have been less generations, and consequently there has been less selection, in the line leading from that common ancestor to man, than in the lines leading to the apes. Further back in the past there was a common ancestor for the higher apes and the lower monkeys. There were less generations, and consequently less selection in the lines

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[3] Dynamic Evolution, a Study of the Causes of Evolution and Degeneracy. By Casper L. Redfield. Pp. 210. New York, G. P. Putnam's Sons, 1914.

leading from that common ancestor to the higher apes than in the lines leading to the lower monkeys. It would be interesting to have some one go through the different species of active animals in this way and then explain what selection had to do with the evolution of higher forms of animals from lower ones.

"Based on laws well known to science there is a hypothesis that the universe is a system running down. It would be interesting to have some one take these laws as a basis and then explain how there can be an evolution (increase) of animal powers by mutations.

"High speed at the trot is not a natural gait for horses. It is an artificial gait which never existed in any breed of horses until forced there by the art of man during the past century. At the beginning of that period running was the only high-speed gait, and horses would break into a run when forced for speed. Now we have natural trotters which will stick to the trot no matter how hard they are forced, and the trotting speed approaches the running speed. The most successful trotting lines are through those animals which were worked hard at the trot, were seldom bred, and had few generations to the century. Opportunity for selection was reduced to nearly its lowest limit in the most successful trotting lines. What theory other than the inheritance of acquired characters will account for this new thing found in the 'born trotter' of today?

"CASPER L. REDFIELD."

Any one who desires to investigate one of these points and wishes more information as to the method of procedure, may write to the editor of the JOURNAL OF HEREDITY, or directly to Mr. Redfield, whose office is in the Monadnock Block, Chicago, Ill. Dynamic Evolution may be considered as an authority on the meaning of any point in the offer. It contains a bibliography of previously published articles, to which reference may be made for details in case any point appears obscure.

Hardy Grains for the North

At the Rampart Experiment Station in Alaska, Agent C. C. Georgeson writes, "We have made many crosses of barleys in order to produce an early beardless variety which shall, at the same time, have a good head and a stiff straw, so it can stand the storms. To this end many and divers varieties have been crossed, and we have results which show a very large variation in the offspring. The plan has been to use the beardless—and, in some cases, both beardless and hulless—variety for the mother plant. This has been pollinated with early varieties of barley which have been mostly bearded, some of them six-rowed like the mother plant, and others two-rowed. We have not yet had time to establish a stable variety. Up to the present, the crosses have split up into a large number of widely divergent forms; thus, for instance, the one and two-rowed black, bearded barley, which was reasonably early, but whose chief merit was that it had a stiff straw and did not lodge badly, has been used for the male parent. The offspring has varied in a most astonishing manner. In most cases the beards have been eliminated, and instead of bristles 4 inches long, sharply barbed, many of the offspring have had abbreviated awns from one-half inch to an inch in length, and terminating in a hood. In color, they have varied from pure white to pure black, through many intermediate shades of yellow and purple. Some have been two-rowed, others six-rowed; some of them have been white or yellow two-rowed beardless, others have been six-rowed and bearded. The work is continued."

EXPERIMENTAL INBREEDING

Important Problem Tested With Various Animals and Plants—Rats Inbred by Dr. King for 22 Generations, Accompanied by Careful Selection and Followed by Excellent Results—The Lesson of Experimental Breeding for the Commercial Livestock Breeder.

PRACTICAL livestock breeders are, on the whole, firmly convinced that close inbreeding, that is, the mating of closely related individuals, is injurious, leading to degeneration and sterility. Their testimony was reviewed by Darwin[1] in a well-known chapter of his book on animals and plants under domestication; and he himself made the first important experimental contribution to the subject, by his plant pollinations, which led him to express the opinion that cross-fertilization is generally beneficial.

Ritzema-Bos (1894) was one of the first biologists to bring forward experimental evidence of value from animal breeding. During six years he continuously inbred a family of rats. In the first four years, covering 20 generations, no bad effects were observed, but in the following 10 generations the vigor and fertility of the race considerably declined. "The average-sized litter in the first half of the experiment was about 7.5, but in the last year of the experiment it had fallen to 3.2, and many pairs were found to be completely sterile. Diminution in size also attended the inbreeding, at the end amounting in the case of the males to between 8 and 20%."

At about the same time, Weismann carried on a similar experiment with mice, starting with nine individuals—six females and three males. "In the first ten generations the average number of young to a litter was 6.1; in the next ten generations it was 5.6; and in the last nine generations it had fallen to 4.2."

Such experiments gave support to the stock-breeder's belief that inbreeding is, in the long run, injurious—although it is hardly necessary to point out that no practical breeder ever inbred to anything like the same extreme degree as was done in these laboratory experiments. Of the various cases of extreme inbreeding of large animals may be mentioned that of Lord Derby, who mated brother and sister for nine generations of race horses, with distinctly bad results, and of J. Cossar Ewart, who inbred the descendants of a pair of goats as closely as possible for nine generations, until the strain practically "ran out."

Experiments with smaller animals, on the other hand, have shown that under some conditions close inbreeding may be carried on for a long time without bad results. Thus, in the case of the little fruit-fly, Drosophila, Castle and his pupils bred brother with sister for fifty-nine generations "without obtaining a diminution in either the vigor or the fecundity of the race, which could with certainty be attributed to that cause. A slight diminution was observed in some cases, but this was wholly obviated when parents were chosen from the more vigorous broods in each generation."

WOODRUFF'S LONG STUDY

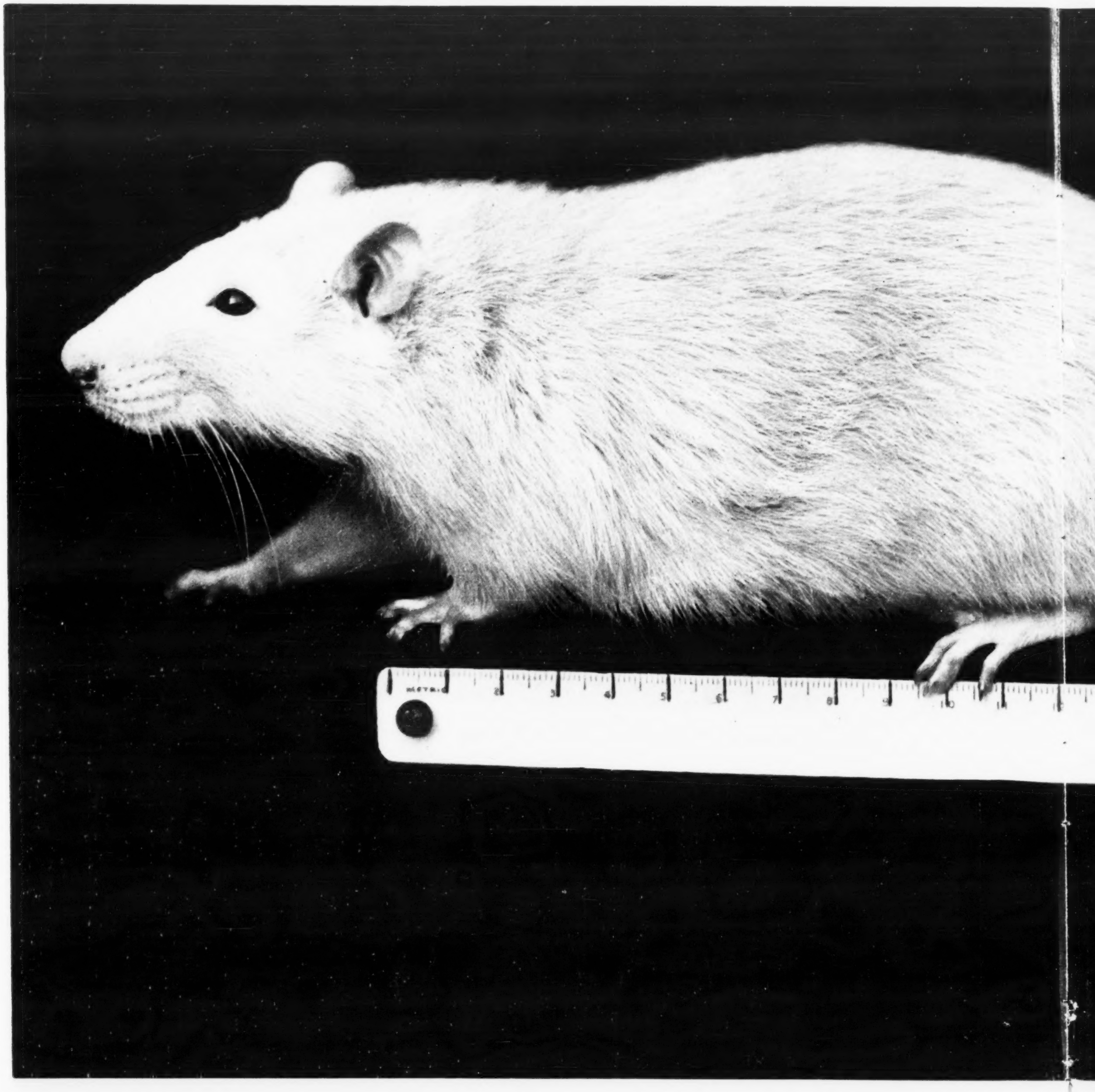
But the most extensive test of the kind is that of Woodruff, who carried the one-celled Paramecium, which usually reproduces by simple division, through more than 3,000 generations, without any marked deterioriation in the stock.

Such investigations, however, with fruit-flies, maize, and the like material,

[1] The evidence cited by Darwin was reviewed at some length by H. Kraemer in the JOURNAL OF HEREDITY for May, 1914, Vol. V, No. 5, p. 226.

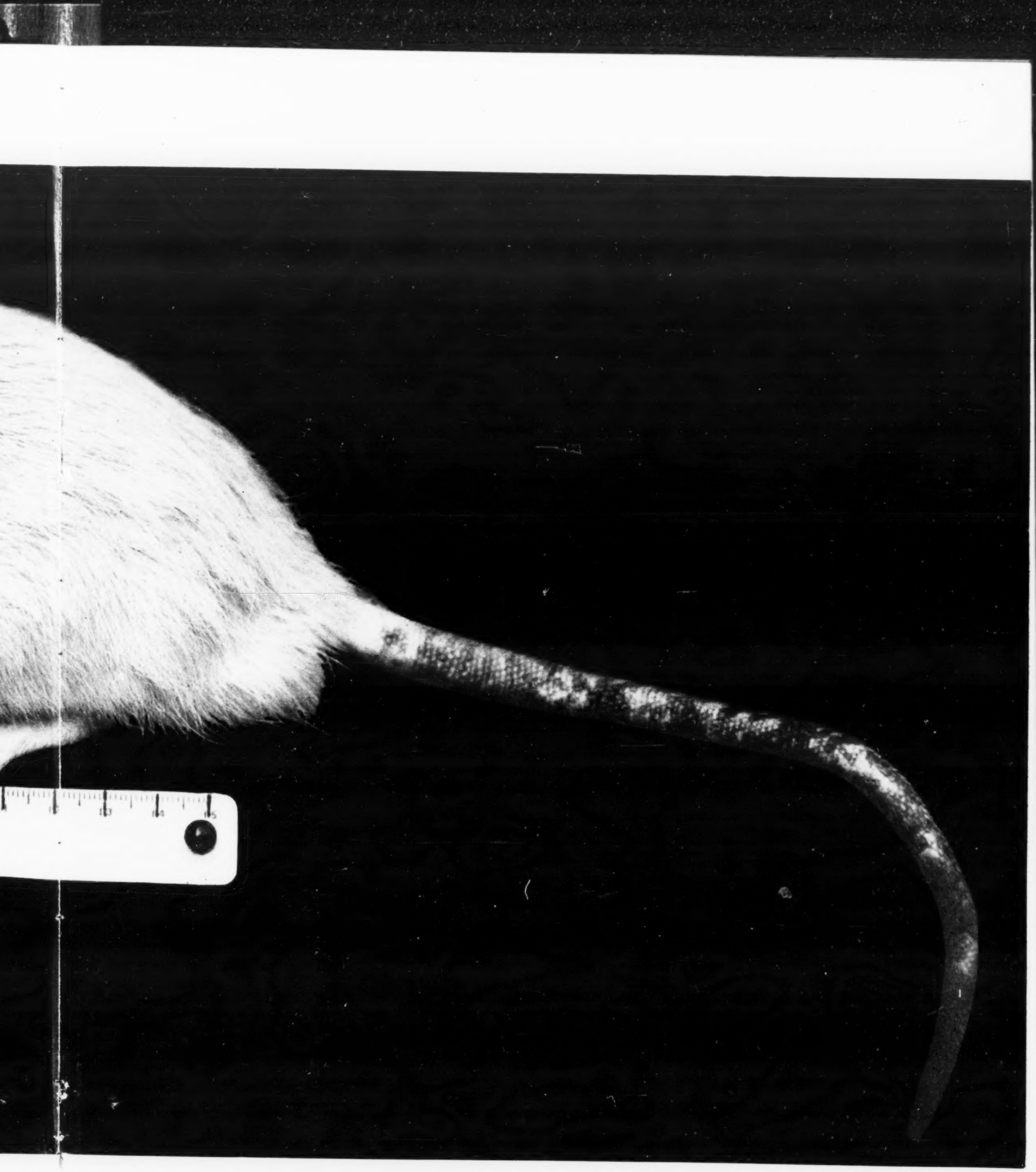
RATS INBRED FOR TWENTY-TWO GENERATIONS SURPASS THEIR ANCESTORS IN VIGOR

Breeders with a superstitious fear of inbreeding or consanguineous mating may profitably consider the albino rats bred by Dr. Helen Dean King at the Wistar Institute, Philadelphia. At the bottom of the above photograph is a pair of rats taken from the ordinary stock of the Institute; this is not inbred. Six years ago Dr. King began to inbreed the descendants of two litters from this stock, and a pair of members of the seventeenth generation of inbred rats are shown in the upper part of the photograph. After twenty-two rat generations, they are larger, more fecund, and more vigorous than the stock rats from which they are descended. They grow more rapidly, and show no more defects or abnormalities than do the rats that are not inbred. The good qualities of rats thus highly inbred show that inbreeding may be of great value to the breeder, if it is practiced on good animals, and only the best saved from each generation for further mating. (Fig. 6.)



GOLIATH, THE LARGEST ALBINO RAT EVER RECORDED, IS THE PRODUC

It has often been asserted by breeders that inbreeding leads to a reduction in size of the animals produced, that it produces runt depended on the kind of animals used, and that if they had many good characters, these good characters are likely to b albino rat bred by Dr. Helen Dean King, of the Wistar Institute, Philadelphia. He is now about one and one-half years old, He is the seventh generation of a stock which has been bred by the mating of brother and sister in each generation. At fifte 320 grams at that age. While the production of such an animal as this does not demonstrate that inbreeding is never inju injurious, and that if carefully selected animals are mated in each generation, the effects of inbreeding may be highly be



E PRODUCT OF SIX GENERATIONS OF THE CLOSEST POSSIBLE INBREEDING

oduces runts and dwarfs. Geneticists have for some years contradicted this assertion, maintaining that the results of inbreeding likely to be intensified in the inbred offspring. The truth of this position is strikingly illustrated by the above photograph of an years old, and is here shown slightly less than life-size; the actual measurement can be determined from the metric scale under him. n. At fifteen months he weighed 550 grams, while the stock rats of the same age, bred without regard to consanguinity, average never injurious, it certainly proves beyond all contradiction that, in so far at least as rats are concerned, inbreeding is not necessarily highly beneficial. (Fig. 7.)

are not easily accepted by the layman as furnishing conclusive evidence in the case of the higher animals. A number of breeding experiments with mammals are therefore being carried on in the United States at present, to throw more direct light on the problem of whether inbreeding is necessarily injurious.

The Bureau of Animal Husbandry of the United States Department of Agriculture has bred guinea-pigs for sixteen generations, on its farm at Beltsville, Md., mating brother and sister in each generation. No results of this work have yet been published.

Darwin pointed out that swine seemed to be particularly susceptible to the evil effects of inbreeding; the Delaware Agricultural Experiment Station is carrying on an experiment to test this point. Describing the work at the last meeting of the American Genetic Association, the director of the station, H. Hayward, declared that every line of descent had ended in disaster. Degeneration of the animals occurred, despite careful selection, in each generation, to get the strongest animals for further breeding.

It is now widely believed, by geneticists, that selection is the key to the results of inbreeding. Obviously, when two parents are mated, each carrying a given character (because of their similar heredity), their offspring will get this character with increased intensity. If the character is good, it is argued, inbreeding ought to be beneficial in respect to this particular character. If the character is bad, however, the offspring, getting a double dose of it, may naturally be expected to be inferior to its parents in regard to that character.

All that is necessary, then, we are told, is to select for further reproduction the best animals in each generation. By so doing the evil effects generally attributed to inbreeding can be at least postponed indefinitely.

Such a statement conforms to a widely-accepted theoretical view of inbreeding. It has not seemed to produce good results in the Delaware station's pig breeding; but in another careful test it has vindicated itself completely.

This test is the experimental breeding of albino rats by Dr. Helen Dean King at the Wistar Institute, Philadelphia, Pa. It was first started to determine whether inbreeding alters the sex-ratio by increasing the relative number of males, as a number of investigators have maintained. Negative results being reached on that point, it was continued to test whether strains of rats with disproportionate sex-ratios could be produced by selection. The success on these lines was described in the January issue of the Journal of Heredity (Vol. VII, pp. 9-11).

It is from the point of view of simple inbreeding, however, that the experiment is of interest here. Its scope will be understood from the fact that it is now in the twenty-second rat generation, that a thousand rats are being produced in each generation at the present time, and that about 10,000 inbred rats have, up to date, been produced, and a large number of them carefully weighed and described at regular intervals.

The experiment was begun six years ago with a stock litter of four albino rats, two male and two female. From these two pairs have come all the rats since produced, and each line of descent has been kept separate, so that there are two series, A and B. In each of these series the closest inbreeding has been practiced in an unvaried way, brother and sister being in every case mated. About twenty selected females in each series are reserved, in each generation, to continue the experiment, and each of these is mated twice to a brother from the same litter.

Although these females are carefully selected from the large number available, it must be noted that the basis of selection is primarily a disproportionate sex-ratio, and the general good qualities of the animal are taken into consideration only secondarily. But as far as is possible without conflicting with the primary interest of the experiment—namely, the question of sex determination—the best rats are selected in each generation, size, vigor, fecundity and similar characters being taken into account. In other words, Dr. King is

trying to avoid evil effects from inbreeding in exactly the way that geneticists have told the practical breeder to go; she is picking out only the best breeders in each generation, and discarding all the unfit.[2]

RESULTS ARE GOOD

The result seems to have demonstrated that the geneticists were right when they advised such a course—at least, as far as rats are concerned. For these laboratory rats, which have been inbred as closely as possible for twenty-two generations, are in every respect superior to the stock rats from which they took their start six years ago, and which have since then been bred in the usual indiscriminate manner.

Beginning with the seventh generation of the experiment, from three to five litters in each generation of each series have been weighed, first at 13 days of age, then at intervals of one month until they were 15 months old. Their growth has been carefully compared with that of the stock rats, bred under the same environmental conditions.

Growth in body weight is practically the same in inbred and in stock albino rats during the first sixty days of postnatal life, both in the males and in the females. After this time, however, inbred rats exceed the stock rats in body weight at any given age. After 150 days of age, inbred males are about 15% heavier than stock males. In the case of the females, which are always smaller than males, there is much less difference between the growth of the stock and inbred rats; nevertheless inbred females are, throughout adult life, about 3% heavier than stock females.

When it is remembered that selection for size has been only secondary, selection for sex-ratio being the first consideration, this increase in body weight appears to be a very striking accompaniment of the inbreeding which has been done.

What of the sterility which is said, sometimes, to be an inevitable result of inbreeding? The rats certainly do not show any falling off in that respect. "We have found that the average litter of stock albino rats contains seven young," Dr. King says.[3] "Records for over 1,200 litters of inbred rats show that the average number of young per litter is 7.4. Litter size in the rat, therefore, is seemingly increased and not diminished by inbreeding, even when, as in these experiments, there has been no direct attempt to increase the fertility.

"Under the conditions in our colony inbred rats live fully as long as do stock rats and they appear equally resistant to disease; so their constitutional vigor does not seem to be impaired as yet."

The reader will perhaps wonder whether there are not a great many "wasters" produced in each generation—animals defective in vigor or in some other respect. It can be said that the proportion of defectives appears to be no larger in the inbred series than in the stock rats. Furthermore, no female selected for breeding has ever proved sterile.

Dr. King sums up the experiment to date as follows:

DR. KING'S CONCLUSION

"The results so far obtained with these rats indicate that close inbreeding does not necessarily lead to a loss of size or of constitutional vigor or of fertility, if the animals so mated come from sound stock in the beginning and sufficient care is taken to breed only from the best individuals."

In the face of the data she presents, one can hardly refuse to accept this conclusion.

It must be noted, however, that the experiment can not, in the nature of things, settle the problem of whether inbreeding is, *of itself*, injurious. The experiment proves conclusively that if

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[2] The only abnormalities so far noted in the inbred strain, since external conditions were uniform, are: one tailless rat, killed by mother soon after birth; half a dozen cases of absence of one or both eyeballs. This latter defect is equally common in the rats that are not inbred.

[3] In an address before the Pediatric Societies at Philadelphia on November 9, 1915. From this address (which has not been published) most of the facts herewith presented are derived.

any injuries result they are not so great but that they can be counteracted by careful selection of the animals used.

And after all, does the practical live-stock breeder need to know any more than that? For the sake of clearing up theoretical views on the subject, it would be highly desirable to get evidence that inbreeding is or is not injurious in itself, wholly without regard to selection; but such can hardly be had from experiment. And as every breeder, under ordinary circumstances, is selecting from his stock all the time, it is sufficient for him, if he is told that by careful enough selection all evil effects have been avoided, and good results gained in an experiment with rats, in which they were closely inbred for a much longer time than would ever be used in the commercial production of livestock.

But no one experiment will settle the general problem of inbreeding. What takes place in rats might or might not be expected to take place in swine; at any rate the Delaware station could not make it take place. And no breeder could be advised to inbreed cattle for twenty-one generations, even with the most rigid selection, and not expect trouble, merely because rats have been successfully inbred for that length of time.

Great progress has been made during the last generation in solving the problem of inbreeding, but the final solution has by no means been reached. It can hardly be reached until we know exactly what inbreeding means physiologically; and in this field we are at present largely dependent on hypothesis.

The results of Dr. King's experiment in breeding rats, and the whole teaching of genetics, however, can be safely followed by the practical breeder to this extent: that he can use a moderate degree of inbreeding through a number of generations without fear of evil results, *provided he is mating the best with the best* in each generation; and that the results in most cases will be a considerable improvement in his stock.[4] The superstitious fear of inbreeding in any form, which long hung over practical breeders, is rapidly disappearing; for the geneticist it long ago ceased to exist.

[4] Much of the improvement in German livestock during the last generation is due to the moderate practice of inbreeding on the advice of geneticists, according to Dr. Georg Wilsdorf. See his discussion of the subject in "German Zootechny," JOURNAL OF HEREDITY, March, 1915, Vol. VI, No. 3, p. 109.

Annual Business Meeting of the Association

At the annual business meeting of the American Genetic Association, held in Washington on January 13, it was decided to hold the next general meeting in connection with the American Association for the Advancement of Science in New York, December 26 to December 31, 1916. O. F. Cook, David Fairchild and Arthur W. Gilbert, whose incomplete term of two years as members of the council expired, were elected to succeed themselves. The secretary's report showed the membership of the Association to be 2,722.

Annual Meeting of the Council

The annual meeting of the council of the American Genetic Association was held in Washington on January 18. The present officers were re-elected. Mr. Kearney was elected a member of the executive committee, to act with the president and secretary. Plans were considered for securing advertising for the JOURNAL.

WHAT TO SAY ABOUT MARRIAGE?

Many of Those Who Seek Help from Eugenics Do Not Receive Satisfying Replies —Others Handicapped by Lack of Sufficient Acquaintance Among Marriageable Persons—Scope of the Science is Not Adequate Unless It Meets These Two Problems.

A. E. Hamilton, *New York, N. Y.*

A POPULAR article in one of our very popular magazines, entitled "Do You Choose Your Children," brought to the Eugenics Record Office hundreds of inquiries concerning heredity in relation to marriage and parenthood. These ranged up and down the emotional scale from cold questions concerning genealogical data to the most intimately confidential outpourings of mind and heart on subjects of vitally personal concern. A casual leafing through of this batch of letters gives an adequate sampling of their trend. The following fragments are typical.

"This article brought home to me things I had never thought of before" . . . "Too late to profit by this article myself but I have two sons who" . . . "Will you trail my ancestors as far back as possible?" . . "I am deeply attached to a certain young lady and on her family history our future relations will probably rest" . . . "My family is seemingly all right, but I am paralyzed in my left leg" . . . "I am now in college and in splendid health, but when a child I had an epileptic fit. What would happen if I married a girl without this trait." . . . "Now that I am engaged the subject of heredity looms important" . . . "If I had read that article a year ago, I would not have married until I had investigated my ancestry" . . . "There are weak eyes on both sides, tendency to catarrh and deafness" . . . "I am intensely interested in the highest development of the race" . . . "Is cancer inherited. Glaucoma. Astigmatism." . . . "My baby was born before time, and lived only a couple of hours, can you tell me why?"

So they run, page after page going into minute description of family diseases, abnormalities, slight deviations from the supposedly normal, apparent tendencies to this or that condition of mind or body. These people want to know about maternal impressions, about the prenatal care of children, about the possibility of overcoming inherited tendencies by proper compensatory training in early years. They bitterly regret the lack of knowledge that was theirs, and equally rejoice in their belief that now this knowledge, backed by all the weight of scientific authority, can be had for their children.

AN UNSATISFYING ANSWER

The Eugenics Record Office answers most of these letters of inquiry with the suggestion that if the accompanying record of family traits is properly filled out, perhaps something may be said in regard to the specific situation.

A small percentage of those who receive these record blanks fill them out and send them back. A small percentage of those that come back are carefully wrought and show that their makers have caught both the spirit and the letter of scientific inquiry into family traits. But the number of people who have the interest, intelligence, patience, perseverance and time thoroughly to fill out one of these rather complicated record blanks is negligible in so far as it concerns the problem of what the science of Eugenics is called upon to say to those who, for themselves or their children, are thinking in terms of marriage.

Eugenics has pointed to the defective fruit on our family trees. It has chilled the hearts of many into furtive inquiry

concerning their future and their children's future. If Eugenics as a science does not answer, nescience will—and it does.

The hands of palmists, seers, chirographers, astrologers, phrenologists and mediums are crossed with silver mounting into hundreds of thousands of dollars a year, for the information they give on the subject of courtship, marriage and probabilities concerning children. The word Eugenics appears already in the literature of the underworld of quacks and fakirs, and on the gilded signs of medical museums and mail-order "Universities." This, of course, is to be expected, for they seize on every instrument of popular fancy to further their trade; but do not the scope of the questions that are asked, and the range of the answers given and paid for in cold cash, suggest that there is a wider field for the scientific Eugenist, even at this stage of the game?

The Eugenics Record Office, through the interest of Mrs. Wortham James, was able to try a piece of extension work in the form of lectures on the general subject of Eugenics. These lectures attracted favorable attention, and were well received largely because to those who heard them the word Eugenics connoted heredity in relation to the problems of marriage and parenthood. Audiences were made up of people whose matrix of ideas was ready to receive new conceptions of science up to a certain limit, and in so far as these lectures carried material that squared in with that limit they were useful; but they usually overshot their mark because the lecturer wrongly assumed that the latest developments in scientific research would find a cordial welcome. But marriage and parenthood to the average college student mean far more than the facts concerning the segregation of unit characters in plants and the inheritance of eye color in man.

THE APPROACH TO EUGENICS

Eugenics as an idea and an ideal of better marriages, better parenthood, better babies and a better race is a drawing card of no small power, but to get Eugenics into the tissue of society as part of its thinking and feeling, science must take advantage of those keen personal interests that, while not strictly biological, are yet very close to the major problems of biology. This, again, can be illustrated with the kind of questions young men and women are asking, questions which indicate the mental content and emotional tendency that Eugenics must recognize and use if it is to make headway.

"I have just got under way with a piece of work that is taxing me heavily, the more so because I thoroughly enjoy it and am making it successful. Next spring I want to be married, and I want to be a mother as soon as I can. I have an offer from a relative to take charge of her two children for the rest of this year, and just devote myself to their care, which means outdoors, happy times, very little strain, healthful hours and many points of advantage for one who wants to be in good shape for motherhood. Now, from the standpoint of Eugenics and heredity, is it worth while for me to sacrifice my work and take up this other line for the good of my children, or will their inheritance be just the same if their stock is sound?"

Had this young woman already filled out a record of family traits, her question would remain the same concerning the welfare of her children-to-be. She wanted a specific answer to a specific question, from someone who had authority that she could respect back of the answer, and she put her question to me because I had the reputation of being an authority on Eugenics. Now I know perfectly well that we have no proof that running a successful class in handcraft work is damaging to the germ plasm, and therefore injurious to our racial stock; but I unhesitatingly told that young woman that if she considered motherhood her capital profession in life, she would be doing the eugenic thing by dropping her job, if she could afford it, and taking her relative's children in hand. I said "if you can afford it" because it might have been that her job was paying her well enough to enable her to marry in the spring, and that per-

haps the other work would not, which would make a difference.

PRESENT SCOPE TOO NARROW

Such questions as this are more and more frequent. They come to physicians, of course, but in the present chaos of contradictions concerning nature and nurture, even our physicians are casting about for some authoritative anchorage for their ideas on heredity in relation to Eugenics. And what are we who represent the cause of Eugenics nearest its fountain head doing to meet this situation? Thus far our tendency has seemed to be to try to draw fine lines of distinction between euthenics and eugenics, and when hard thinking about such things as the physical and spiritual preparation for motherhood, or the technique of the affections are concerned, to retire into the confines of our laboratory experience.

Eugenics needs, primarily, the moral support of as many people as possible for its activities in sound research. But in order to keep the attention, interest and sympathy of its friends it must continue to have something to give, and it must continue to widen its scope as new situations arise within its field. Not that it must shift its base one iota, but only that it keep its fundamental purpose constantly in sight by showing its relations to problems of vital human interest wherever these may touch its fringe.

What shall it say, for instance, of marriage bureaus?

More people read *Physical Culture* and other magazines that try to deal fairly with the problem of mate-getting in most "unscientific" ways than will be reading THE JOURNAL OF HEREDITY for many years. Bernarr MacFadden once tried out a page or two where advertisements could appear of young men and young women who wanted to marry each other on a basis of mutual interest in physical culture and outdoor life. But *Physical Culture* has been getting more and more "respectable" of late, and I have missed those interesting human items that now seem to be left entirely to the matrimonial brokers and their cheap weeklies and monthlies.

But even in these journals that never breathe the air of our railway and subway news stands, there are advertisements that ring a wholesome note.

> "I am a young man of 35, German descent, Protestant, refined, college graduate, best of health, very fond of music, play the violin, blonde, blue eyes, brown hair, height 5 feet 7½, weight 145, and am very young looking. Have no bad habits. Occupation, electrical engineer, in good standing. Wish to marry a sincere lady of education, refinement, and one who is broad minded in religious views, having some means, and who wants for a husband a healthy, active man, a lover of nature, literature and all things that tend to elevate one to a higher artistic, spiritual and intellectual life. For particulars address"—etc.

There are eighty-four advertisements from young men on the page from which I have lifted this sample. It may be that this sort of thing is not in good taste, that many advertisements are run for purely commercial reasons, to catch small capital through marriage as a bait, and that these matrimonial journals lend themselves to much quackery. But the fact remains that they are sometimes the only available means for young men and women who want to marry outside their narrow circle of acquaintance, to get in direct touch with other young men and women of like tastes and inclinations. And the cheerful frankness and straightforwardness of these announcements is positively charming in our world where such things are under respectable tabu.

The influence of the astrologer is apparent in many of these attempts to break through the loneliness of life, as though good marriage were contingent on the zodiac.

> "Welsh-Scotch, brown eyes and hair, ruddy complexion, in perfect health, born under canser sign, character will stand the most rigid examination, lover of home and children, interested in eugenics and physical culture, outdoor life and new thought. Do not use tobacco or liquors. . . . I want a good, loving wife between the ages of 26 and 29, a home-keeper and a Christian, prefer an Eastern Star or a Rebecca, with blue eyes, blond hair, height 5 feet 8, weight 140 to 160. Only those who are really interested need apply as I am very busy and do not care for foolish correspondence."

I have been surprised and sometimes not a little shocked at the questions that have been put to me after lectures, in private, by people of recognized standing as to ability and intelligence in their communities. The influence of the cheap and bogus literature on marriage, parenthood, prenatal influences, crops out everywhere when the lid of tabu is lifted and people discuss what they know or think they know or want to know, with one supposedly familiar with the facts. When I find, after lecturing for forty minutes to a group of three hundred physicians, that I am cornered for private discussion of the science of phrenology in relation to heredity and mate selection, that doctor and layman alike have fond beliefs in maternal impressions and weird psychic influences affecting the unborn, I can read such advertisements as that of our friend who is interested in Eugenics and the sign of "canser" with charity. Says another:

> "Correspondence preferred with those having birth dates from April 19 to May 20, January 20 to February 19 or from August 22 to September 23."

Religion seems to be stressed almost equally with social position, economic outlook and positive qualities of health and character. Some of the frank limitations as to correspondence are a bit amusing at times:

> "Widows with children, Catholics and flirts need not write."
>
> "Catholics, divorcees and insincere persons kindly do not write."

There does not seem to be such tacit acrimony on the part of Catholics toward Protestants. However, the religious complex, as our modern psychologists label it, is undoubtedly a strong and important factor in marriage selection and one with which any broad science of Eugenics will have to deal.

One of the finest young doctors in my acquaintance, a man of exceptional personality and intelligence, asked me what in the world he could do about being in love with a Catholic girl, whose religion his intellect refused to accept, and yet who made religious harmony a cardinal point in their relations. He did not advertise for a wife, but from the distraught state of his mind concerning his engagement and marriage, and the effect of possible disharmonies upon family and children, I should almost judge that he would have done more wisely had he consciously and directly put himself in touch with a girl whose brain functioned more like his own.

In comparison with the daily topics of our respectable press, and the bulk of our journalistic fodder, these cheaply printed and homely worded matrimonial sheets are a veritable step into higher and happier levels of reading and thinking. Somehow the will to believe that most of these expressions of aspiration for the solid goods of life are real and genuine gives one a renewal of confidence in the heart of the common people who write them out and have them printed at the rate of a cent a word.

> "Is there some good Christian lady between 25 and 40, of good character, good cook and housekeeper, fond of children and ranch life, who wants a good home? . . . " etc.
>
> "I am a young man of 26, college graduate, come from a well educated, aristocratic family, occupation druggist and chemist, have the best of health, fond of books, opera, athletics, 6 feet tall, weight 170 pounds . . . " etc.
>
> "Unable to accomplish a burning heart's desire unaided, advertiser takes this unconventional method to obtain the longed-for wish. Active German-American, age 50, a Christian, perfect health, absolute teetotaller, never married, have varied business experience. Wish to hear from a marriageable maiden or unencumbered widow who has a hankering for free, outdoor life . . . " etc.

Health, love of children, desire for a home, sound financial standing or ability to support a wife and maintain a home, and good character are the principal points emphasized throughout. Personal idiosyncracies are dwelt upon sometimes at length, and seem quite amusing to us who merely read the printed word; but from what little I know of the class of people who write these ads., mechanics, farmers, railroaders, mill foremen—mostly from our solid labor stuff—they are usually frank expressions of a deep and earnest desire.

One of the cardinal points in Galton's eugenic program was the study of in-

fluences affecting marriage. One of these influences is undoubtedly the willingness of a growing number of us to approach marriage frankly and open-eyed as to the desirable elements that go to make it a success. Another influence, that results in a demand for such vehicles as our marriage papers, is the narrow range of acquaintance between our young men and young women. This is especially the case in our rural districts, from which most of these pathetic advertisements come. But it is true wherever I have travelled, and while such a subject does not lend itself easily to scientific treatment, a discussion of some of the related facts that are constantly coming to hand, and wherein we may read the signs of the times may prove profitable. In a subsequent article I am to be allowed the privilege of presenting these.

Plant Breeding in Kansas

Three distinct lines of plant breeding are under way at the Kansas State Experiment Station: (1) the breeding of cereals for disease resistance; (2) the breeding of alfalfa for drouth resistance; (3) the breeding of maize for the same quality. Numerous hybrids have been made between four rust-resistant wheat species—an emmer, two durum wheats and an einkorn—on the one hand, and various pure lines of winter wheat originated at the station, on the other. A considerable number of hybrids have been produced recently between Khapli, one of the best resistant spring grains, and a number of pure lines of winter wheat. In the endeavor to breed smut-resistant sorghums, many crosses have been made between milo, which is entirely resistant to both the grain and the head smuts, and two kafirs and feterita.

The alfalfa project is being carried forward by hybridization between various strains and species of *Medicago sativa*, *falcata* and *ruthenica*; the drouth-enduring species *M. arborea*, a perennial plant from the drier parts of the Mediterranean; and some drouth-resistant root-propagating alfalfa plants obtained from the Colorado Experiment Station; and, as the other parent, some of the best pure lines of commercial alfalfa, picked out by the department of botany at the Kansas station.

The maize-breeding project is further advanced, in that three families out of forty-four originating from hybrids of 1910 showed evidence of extreme resistance to drouth in the F_2 generation during the very severe summer of 1913. Of these three families, the most conspicuously successful originated from a cross of the drouth-resistant Mexican variety known as Esperanza with the F_1 generation of a cross between a western Kansas white dent corn known as Sherrod's and a strain imported from China. Under the high temperatures of the summer of 1913 the leaves of the creation described did not burn, fire or cook, but only rolled slightly, while fields of ordinary corn were practically destroyed. The strain has an unusually strong development of leafage and bears a fair-sized ear of the white dent type; the station thinks it will be a marked success when tried on a commercial scale.

"Journal of Heredity" Used as College Textbook

The current issues of the JOURNAL OF HEREDITY have been designated as one of the required textbooks in the class in Heredity and Genetics, by Professor William H. Gates, of the Louisiana State University, and special arrangements have been made to supply the JOURNAL to the twelve students in the class during the present semester.

BUD VARIATION

Washington Navel Orange "Running Out" as a Variety—Reason Found to be Due to Wrong Methods of Propagation—Can be Conserved by Utilization of Good Bud Variations and Avoidance of Bad Ones—Methods of Practice.[1]

A. D. SHAMEL

Physiologist, Bureau of Plant Industry, U. S. Department of Agriculture, Riverside, California.

OF THE many factors influencing the production of a fruit tree, there is one which until lately has been often overlooked, and which we wish to consider briefly as it affects the navel orange industry of California.

This factor is the variation in types of trees and fruits resulting from the propagation of sports or mutations.

While we do not wish to underestimate the importance of other factors, we do feel that the relation of variable-type trees and fruits in our groves to profitable orange growing has been largely overlooked by everyone concerned. We hope to be able in this discussion to call attention to the importance and significance of the condition of bud variability existing in our orange trees, from the viewpoint of six years of continuous investigation of this matter, and to offer some suggestions in this connection for the improvement in production, both as regards quantity and quality of the Washington Navel orange variety.

It will not be possible here to go into any of the details of our experiments and observations. In a general way these investigations have been carried on by means of continuous individual tree study. In our experimental plots we have usually selected 100 trees for a performance record plot. Frequently we have several plots in one orchard, so as to take into account all possible differences in soil conditions in a given orchard.

In addition to these select plots, where detailed individual tree and fruit studies are made, we have been able to study individual tree performance record data secured by several orange growers. These data are usually made up of the amount of fruit produced by each one of the trees in the orchard, together with some notes as to the commercial quality of the product of each tree.

VARIETY BADLY MIXED

The results of our investigations have shown clearly that in the Washington Navel orange variety we have a number of diverse types, many of which are undesirable and worthless. It is our observation that the younger groves, that is, those farthest removed in time from the parent trees, show a larger proportion of these inferior types than the older orchards, or those not so far removed from the two parent trees. In other words, our experience shows that owing to the lack of careful bud selection and to poor propagation methods, the proportion of poor type trees is constantly increasing in the younger bud generations. This process of varietal deterioration in varieties propagated from seed is frequently called the "running out" of the variety. As a result of many observations in different navel orange orchards, varying in age from the first planted grove in California to those just coming into bearing, we are reluctantly forced to the conclusion that the Washington Navel orange variety is "running out."

[1] Part of an address before the California State Fruit Growers' Convention, Visalia, Cal., November 19, 1915.

The reason for this condition is easily found upon investigation. Of the eleven common types of the navel orange in California, the most undesirable ones from the standpoint of fruit production are those showing the greatest vigor of growth. The trees of these types throw unusually large numbers of suckers, which have been, until recently, highly prized for budwood. Naturally, under the existing methods of propagation, a large proportion of budwood is cut from these vigorous vegetative trees and a comparatively small proportion of budwood from the trees of the productive and desirable types.

Another way of explaining the running out of fruit varieties by reason of the lack of intelligent bud selection in propagation, as in the case of the Washington Navel orange, is the difficulty of propagators in securing budwood from the best and most productive trees. There is no question but that it is difficult to secure large supplies of non-bearing budwood from the best trees, particularly the sucker growth, because such trees usually produce but little sucker wood. On the other hand, by the use of fruit-bearing budwood instead of sucker wood for propagation, there is no difficulty in securing adequate supplies of budwood from the best trees. In fact, if fruit wood is used for propagation instead of sucker wood, one can secure more budwood from good trees than from poor ones.

MANY DRONE TREES

In our performance record plots, located in some of the best navel orange groves in Southern California, we have found that about 25% of the trees are drones, that is, are unproductive and undesirable from all commercial standpoints. Our records show that if these trees had been replaced by the average of the remaining 75% from 1910 to 1914, inclusive, these orchards would have produced about $100 per acre more than was actually the case. These figures are from the actual figures of production and from the prices actually realized for the fruit from these orchards in eastern markets. One of our cooperators, who has kept an individual tree record for the past four years on a large acreage of navel oranges, tells us that his figures show a loss of about $100 per acre each year as a result of the presence in his orchard of drone trees. In view of the close agreement of our experimental and cooperative commercial records, I think we can safely conclude that in our best orchards the loss from trees of poor types has been about $100 per acre annually. Of course, in poorer orchards, especially those having a notorious mixture of types of trees, the loss has probably been much greater. How much disappointment, loss of opportunity, and heartache have been the result of the past system of propagation of our navel orange and other fruits no one can estimate. We have made tree census records in certain navel orange groves which show more than 70% of inferior type trees. These orchards have blasted the hopes and opportunities for success of many men and are blights upon the fair reputation of our citrus industry.

This state of affairs need no longer exist, for we now know that many, if not all, of these inferior trees in existing orchards can be replaced with superior ones, and that the most productive and valuable type of Washington Navel orange can be isolated by bud selection based on performance records, so that this variety, perhaps the most important and valuable in all horticulture, can be conserved and improved, instead of being allowed to continue its deterioration until it altogether "runs out."

ACCURATE RECORDS NEEDED

The first essential to progress is individual tree records to give definite and reliable information as to the performance and behavior of fruiting trees. Individual tree performance records can be compared with the Babcock test for dairy cows, trap nests for laying fowls, centgener tests of strains of corn or other grains, and other methods for securing useful and valuable knowledge of individual animal or plant behavior. The importance and value of individual tree records can only be fully appreciated upon actual use

and trial. So far, in our experience, we have failed to find a user of individual tree records who is not fully satisfied as to the value of this work.

If the amount and quality of fruit produced by each tree in the orchard during a period of several years is known, we are at once able to locate the "drone," "robber," or off-type trees and limbs, so that these trees may be replaced with the best type, usually by top-working entire trees with carefully selected buds, or the removal of the undesirable limb sports by pruning. In other words, the individual tree records furnish a reliable basis for the removal of the drone trees and limbs, and the development of uniform orchards. The advantage of uniform orchards can well be appreciated by those who have to do with the picking, assorting and handling of crops of fruit, as well as from the standpoint of the improvement of the quality and quantity of the yield of orange groves as a whole.

Another most important advantage of the collection of individual tree records is the location by this means of desirable trees as sources of budwood for propagation. No intelligent or unprejudiced person studying our best orange groves in the light of several years' individual tree records, will ever be satisfied with buds secured in the ordinary manner. As one prominent nurseryman recently expressed it: "The day of the ordinary nursery tree is about over in California." We are very glad to say that many California and other nurserymen are adopting the use of individual tree records as a basis for the selection of parent trees for propagation. Several of the leading and most successful citrus growers in California have repeatedly told us that they would not take an ordinary nursery tree as a gift, under any possible circumstances.

We have carefully worked out what we believe to be the most practicable method of keeping individual tree records. It includes the numbering of every tree in the orchard, and the record of its yield by a man detailed for that purpose at the picking season. It is not necessary here to give the details of this method, but we wish to emphasize the fact that some such method is an absolute prerequisite of successful bud selection.

BUD SELECTION

Our interpretation of the term bud selection is the selection of buds from individual trees and limbs of known behavior and, of course, commercially speaking, from those trees and limbs producing the most regular, largest, and best crops of fruit. We have failed to find, in our six years of contact with orange growers, one of experience who has any doubt as to the importance and value of bud selection. We may also add that we have also failed to find during this time a deciduous-fruit grower, or any experienced propagator of vegetatively propagated plants, who has any doubts as to the value of intelligent bud selection. The only criticism we have heard in this connection is that concerning propagators who claim to use care in bud selection, but who are known to use only the ordinary methods of securing budwood with little or no attention to or knowledge of the trees or limbs from which the buds are cut.

We have actual knowledge and definite information of the origin of some of our most valuable horticultural and other varieties from bud mutations, and the propagation of many uniform and more than ordinarily productive and profitable orchards of trees or plantings of vegetatively propagated plants, as a result of systematic bud selection by the propagators. We have been so insistently taught that the only improvement of fruits possible is the origination of new varieties by hybridization, that some of us have overlooked the more important and practical field of the conservation and improvement of our valuable established varieties by bud selection. The same condition existed not many years ago with respect to the improvement of corn, tobacco, cotton, and other farm crops by seed selection. It is not likely that any sane person today would take the stand that it is impossible to improve our established varieties of farm crops by seed selection. However, a

few years ago many people had grave doubts that anything of value could ever be accomplished by seed selection. We are now ready to assert that equally good results can be achieved by bud selection as has been accomplished by seed selection, in which we had the good fortune to be of some service in the case of the improvement of certain varieties of corn, tobacco, and other crops propagated from seed.

SELECTION FOR PERFORMANCE

The best method of bud selection, we believe to be that of securing buds only from those trees having satisfactory performance records. The performance records of trees selected as parent trees should include not only a complete record of several successive seasons' production, but also all available or possible information as to the presence of sports, or off-type fruits, in the crops; and all other information of value in considering the relative value of a tree as a source of budwood for propagation. We hope eventually to include progeny tests of select parent trees for consideration in the selection of the best budwood. When this point is reached, we will have established sources of genuinely pedigreed buds. In order to lay the foundation for pedigreed buds, performance records of parent trees are essential. With this information, together with performance records of the progenies of the parent trees for one or more bud generations, pedigreed trees will become an accomplished fact.

After the parent trees have been selected, the next step is the selection of the budwood for propagation. As a result of our experience in this connection, we have adopted the practice of cutting for budwood only that growth bearing typical fruits. This has been called a radical step. It has many advantages to recommend it. The only objection that has been offered against this method in practice, so far as we know, is that such budwood is small and the buds may not live as well as the "fat" sucker buds. We have assisted in the propagation of hundreds of thousands of fruit-wood buds during recent years. One illustration of the successful growth of these buds will show how they have behaved on the whole in our experience. A cooperator budded a nursery of more than thirteen thousand orange seedlings in 1914, using only fruit-wood buds cut from Valencia and Washington Navel orange budsticks, none of which was of greater diameter than that of an ordinary slate pencil. This budwood was in every case bearing typical fruits and was of the period of growth preceding the bloom producing these fruits. The budsticks contained, on the average, five buds each Out of over thirteen thousand seedlings so budded, only two buds failed to grow. We could offer many other similar experiences if necessary, and have only one report of any difficulty with the use of such buds in either seedling stocks or topworked bearing trees.

BUDWOOD CAREFULLY PICKED

A little reflection will reveal some of the reasons for using this character of budwood. The most important one is that it enables the bud cutter to avoid taking budwood from off-type limbs or sporting branches. This is particularly important where few or no performance record data are available. This method naturally tends to the cutting of most budwood from the best bearing type of trees. The old sucker budwood method led, naturally, to the cutting of the most budwood from the poorest bearing type of trees. While we have no absolute proof, we feel inclined to believe, from our observations to date, that fruit-bearing budwood produces earlier bearing trees than those propagated from sucker wood. It is absolutely certain in our experience that the buds from fruit wood secured from heavy bearing type trees produce trees of considerably earlier bearing habits than those propagated from sucker wood cut from trees having a tendency for the production of large numbers of suckers.

After the typical fruits, by which we mean the best, and only the best, from the select standard type trees, have been severed from the budsticks, they can be included in the regular pick, providing care has been used in cutting them so that they will not have been

VARIATION IN ORANGES FROM A SINGLE TREE

This Washington navel orange tree was grown from a single bud. Conditions, were, therefore, as favorable as possible for the production of uniform fruit. Yet it is obvious that the fruit is far from uniform, some being good and some nearly worthless. The existence of such a condition in orange groves has been the cause of great financial loss in the past, but by the practice of bud selection, this loss is being gradually eliminated. (Fig. 8.)

mechanically injured. In practice we rarely attempt to save the fruits cut off with the budwood, on account of the extra time needed to care for them properly and insure their freedom from injuries.

Our practice is to use this budwood as soon as cut from the tree, or as soon as practicable. If it is desirable to hold it for some time, the budwood should be packed in moist, not wet, sphagnum moss, and stored in a cool place. If the budwood is likely to be kept for a long period, we would advise first moistening the moss in which the budwood is to be stored, then sterilizing it with live steam for an hour or more, afterwards drying the moss by running it through an ordinary clothes wringer.

We cut all budwood possible from a select tree, tie it in a bundle, and place a tag with the bundle, bearing the parent tree number. The buds from a parent tree are all inserted in order and the budded trees numbered, so that the buds can be traced back at any time to the parent tree. Whenever practicable, we would like to see this plan carried out so that additional knowledge of the results of bud selection may become available for the benefit of the citrus industry as a whole.

BUD IN THE SPRING

The best time for cutting buds and budding varies with conditions so much that no general rule can be given in this respect. Fall budding, allowing the buds to remain dormant until spring, has been frequently found to be satisfactory. As a rule, however, our observation has been that spring budding,

when the bark slips easily on the stocks, is safest, and likely, on the whole, to give the best results.

The character of the stocks to be used for the propagation of our best types of the Navel orange is probably more important than we realize. Unfortunately we have little information of value on this point. It is a safe plan, however, to use the kind of stocks which have heretofore given best results until some better stock is discovered and thoroughly tested. The inferior seedlings should be discarded and only the vigorous-growing and healthy ones used for budding work. The buds should be inserted fairly high in the stocks so that the bud union will not be buried when the young trees are transplanted.

To sum up: The conservation and improvement of the Washington Navel orange and other citrus varieties can be effected by the isolation and propagation of the best and most valuable types through bud selection based on performance records. The most effective means for determining the relative value of the types and of the individual trees in these types is performance records. In any event, any intelligent system of bud selection is better than none. The indiscriminate cutting of budwood and its propagation, for some one to grow and be disappointed with during long years, is little less than criminal, now that better methods have been tried and proven to be a success.

Breeding the Pecan

"My first successful work at tree breeding was in the union of the two best paper-shell pecan trees growing in San Saba County," writes E. E. Risien of San Saba, Texas, in the Proceedings of the National Nut Growers' Association. "The nuts of these trees were not large, but had qualities in them that I wanted to see blended." Cross-pollination in May, 1904, was interrupted by storms, but resulted in the production of fifteen nuts. "The best nuts are not found near the body of the tree in protected parts, so I didn't consider these fair samples. These fifteen nuts all germinated and grew. The mother was San Saba, the father tree Sloan. These fifteen little trees were not long in showing great variations both in growth and in the leaves. . . . The next year they were cut to the ground to get buds suitable for top-working. By managing them this way, possibly eight or ten years were saved in the time of fruiting. Anyway, I got to see sample nuts from the union of these two old trees, that were growing 27 miles apart, in five years from planting the seed. This little crop of nuts was an eye-opener, for they revealed to what extent those two trees bred back to the common wild types, which were mostly in evidence; and that the pollen proved to be the prepotent factor was also plainly shown, both in the character of the trees and in the nuts." Further crosses were then made; a combination of the varieties San Saba (seed-bearing parent) and Atwater (pollen-bearing parent) resulted in a lot of poor trees, but one prize, named Venus, a vigorous tree with large, highly colored nuts, which ripen a month later than either of the parents. "My third experiment was to use Texas Prolific for the mother tree, Atwater for the father tree. I have fruited a great many seedlings of the Texas Prolific fertilized by the winds and insects, all of which have been disappointing; but in fruiting the offspring from the union of these two trees the result was to get some prizes and many surprises. The perfect blending, however, I only found in one. It is a beauty; I have named it Banquet. It is large, too—very large; immensely prolific; ripens a week earlier than either parent, and retains that bright coloring characteristic of both sides. This alone gives it a distinction from the common herd. In fact, with this the 'razor-back' stock may now be considered pretty well bred out, and from the nucleus which I now have, it will take but another generation or two of our well-bred western nuts to invite criticism from the most fastidious."

CORRIEDALE SHEEP

Breed Now Being Tested in United States Is Result of Cross-Breeding in New Zealand 30 Years Ago—Breeds Remarkably True with Very Little Tendency to Reversion—Ancestral Characters Seem to Have Blended—How the Breed Originated.

F. R. MARSHALL

Senior Animal Husbandman in Sheep and Goat Investigations, Bureau of Animal Industry, U. S. Department of Agriculture, Washington, D. C.

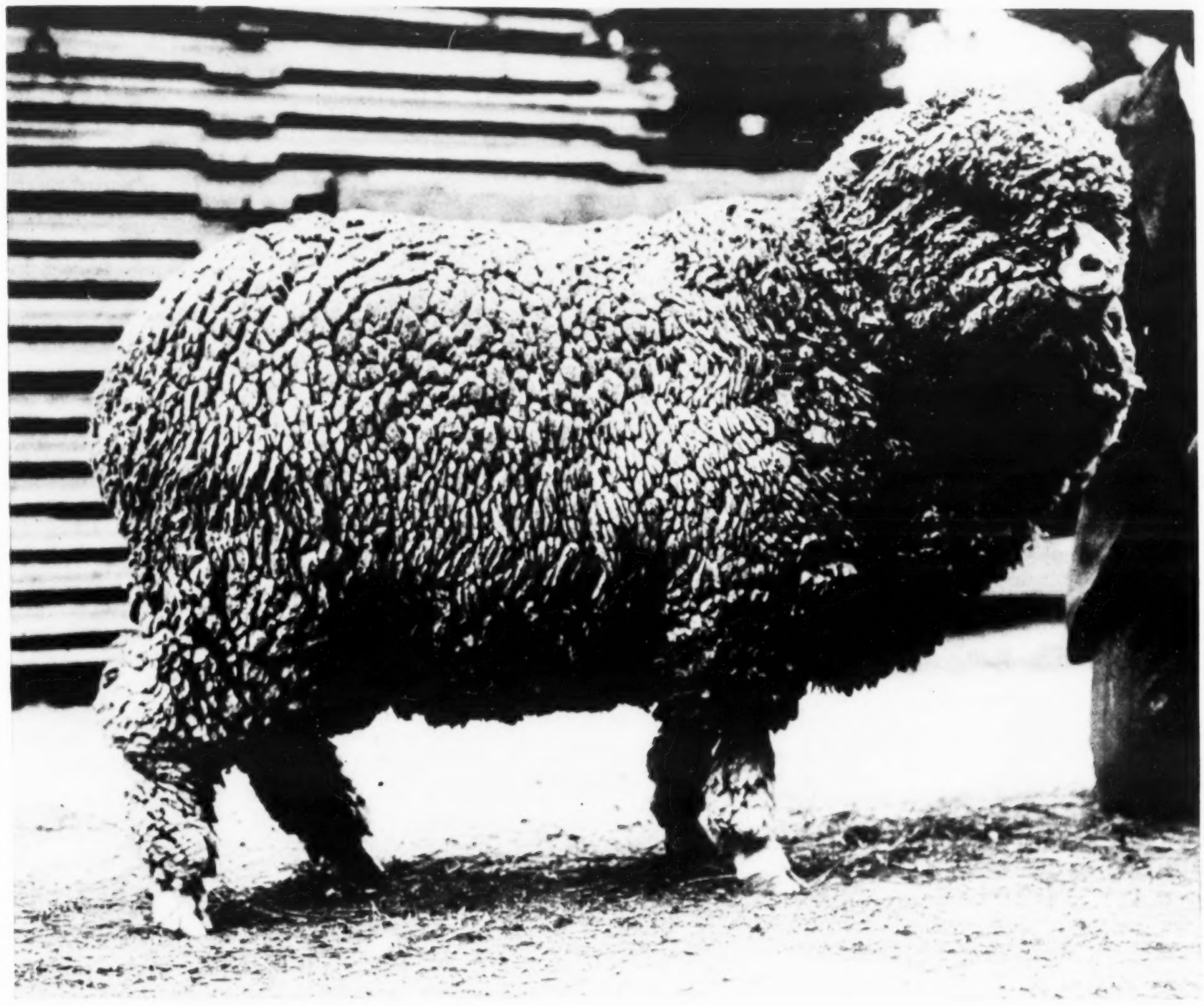
THE importation of seventy-five Corriedale sheep from New Zealand by the United States Bureau of Animal Industry a year ago has attracted considerable attention and well-meant criticism. Six head of Corriedales had reached this country a few months earlier than the Government's importation. The bringing of a trial importation of Corriedales at Government expense had been urged on account of the need of testing the breed's adaptability to Western State conditions before the making of private investments in stock of the breed. Although the ewes of this trial importation have done well during their six months stay on a Wyoming range, there has as yet been no opportunity to know the effects upon them of our rigid winter nor to see a twelve months' growth of wool under the conditions for which it was desired they should be tested. Nevertheless, during the past year three parties have imported other Corriedales to establish breeding flocks.

The demands of recent seasons for both wool and meat have greatly increased the popularity of the cross-bred range ewe. Rams of the long wooled breeds are preferred for crossing upon Merino ewes to produce the cross-bred stock ewe, on account of length and weight of fleece and the greater mature size over that of the cross-bred offspring sired by representatives of the down breeds.

It is surprising to find to what extent the cross-bred ewe is sought in territory commonly supposed to be the permanent and exclusive domain of the hardy and long tried Merino. This cross-bred ewe produces the class of wool that has been in demand in recent years; she has a greater marketable weight than the Merino ewe and her mutton qualities derived from her Lincoln or Cotswold sire add greatly to the carcass value of her offspring. The drawback of this ewe lies in the difficulty of perpetuating her type. A second or third cross of long wool blood obliterates the necessary herding instinct peculiar to the Merino alone. Crossing of Merino rams soon loses the size of carcass and the length and type of wool imparted by the long wool. In neither case can there be continued progress in bringing the flock nearer to the type approximately realized in the first cross.

VARIATION AND REVERSION

While the cross-bred ewe has been deemed a necessity, her brother, the cross-bred ram, has in the main been regarded as impossible for breeding purposes. The lack of uniformity in the offspring of cross-bred parents is well-known. The teachings of the new school of geneticists that has arisen since 1900 have reached the range sheepman, and while not understood have been regarded to a surprising degree. The proneness of the practical man to out-theorize the professional theorist is shown in his frequent adherence to the idea that the offspring of cross-bred parents always revert to



THE BASE OF THE CORRIEDALE BREED

Fine combing Merino ewe, champion in show of that type at Christ Church, New Zealand, 1914. The Merino is the most important fine-wool breed of sheep at the present time, but is inferior in meat production to some other breeds. New Zealand breeders a generation ago undertook to produce a new breed, which should be valuable for both wool and mutton, and they proceeded by crossing heavier types of sheep on the Merino. The ewe here shown is probably about the same type as that used in this very successful experiment. (Fig. 9.)

the original parental types, in spite of the fact that there is not wanting evidence of contrary results. Since market demands for meat have brought the carcass side of the range ewe into greater prominence a few western range operators have made use of first cross rams representing the type they desired in their ewe flock. Owing largely to the uncertainty of tenure upon grazing land, arising from the absence of any governmental public land policy, very few range sheep raisers are equipped to mate their ewes in enough separate groups to permit adherence to a definite and constructive plan. Little information can be obtained regarding the offspring of these cross-bred rams, and there has been practically no progress toward fixing the type of sheep that was at hand, seemed certain to continue in demand, and had not been perfected in America or Europe.

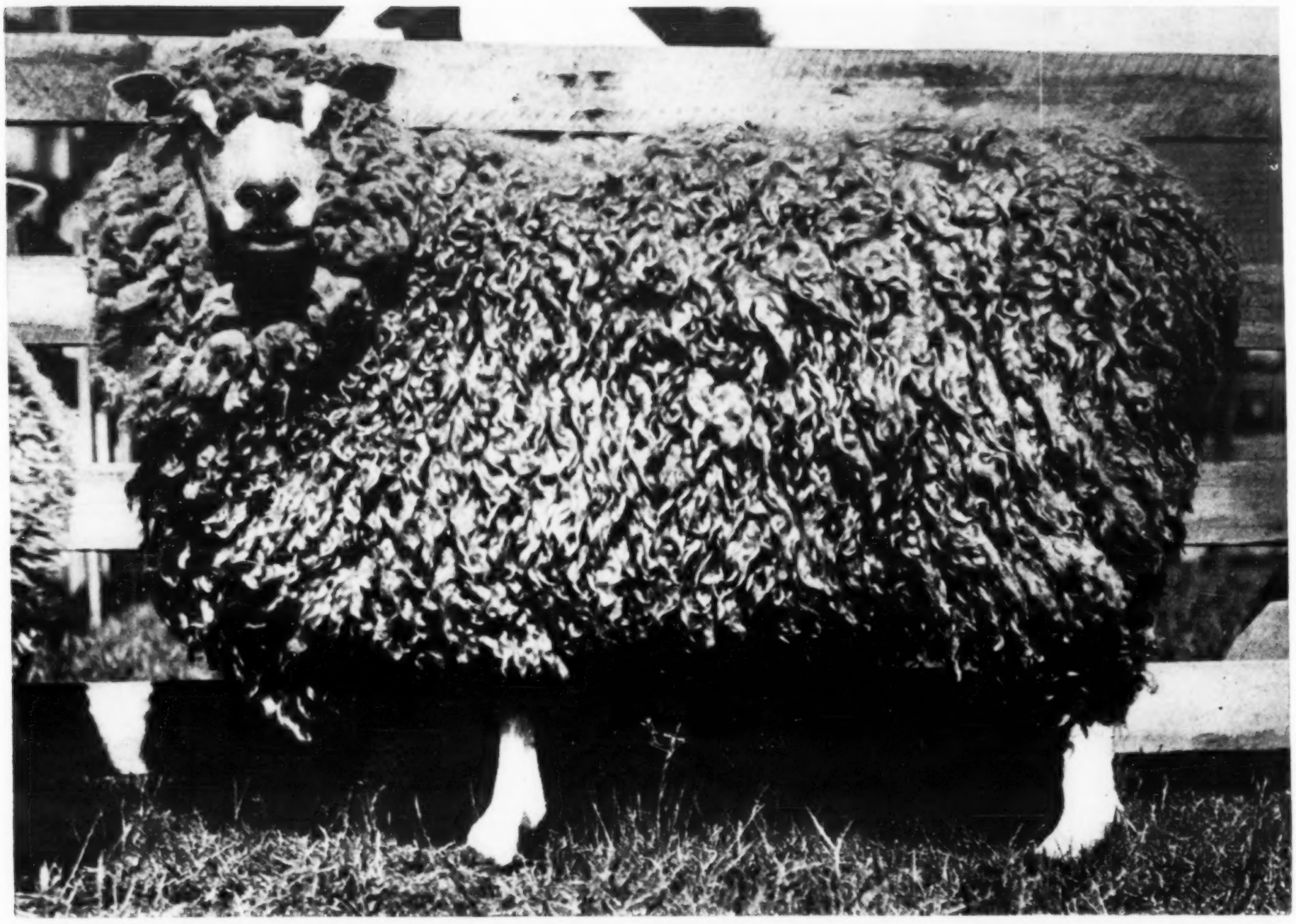
In the Dominion of New Zealand however, sheep raisers of thirty years ago had met a condition and demand quite similar to that confronting western American pastoralists in more recent years. New Zealand's climatic and feed conditions are very favorable to the growth of a long stapled wool of fine spinning qualities. This fact, to-

ONE OF THE PARENTS OF THE CORRIEDALE

Lincoln sheep were crossed on Merinos in order to produce a breed that would unite the long fleece and large size of the Lincoln with the superior wool of the Merino. The Lincoln ram here shown is probably about the type used in the establishment of the Corriedale breed; he was champion at the Christ Church, N. Z., show in 1914. Owned by the New Zealand and Australia Land Company. (Fig. 10.)

gether with the extra weight of fleece procured from ewes having half long wool blood, gave rise to a good deal of crossing in the seventies before the meat trade had seriously affected the sheep husbandry of the island dominion. Later the establishment of the frozen meat trade increased the popularity of the cross-bred sheep and today New Zealand has less than 10% of Merinos among its flocks. The foregoing might be said to relate to the economics rather than to the genetics of the Corriedale but it sets forth the motives of the founders and the material used in forming the breed that has now reached the United States, South America, and Australia.

The Corriedale is a result of the original practice of crossing long wool rams upon Merino ewes. The problem before the New Zealand sheep raisers in the seventies and eighties was the same as that now interesting many western American flockmasters. The cross-bred ewe is a very useful animal but at present can only be secured by combination of two separate pure types. While many of the New Zealanders graded up their flocks by the continuous use of rams of the long wool breeds, others continued to breed half-bred rams on cross-bred ewes and a few conceived the idea of fixing the type of the first cross sheep. In less than forty years there has been produced a breed which, impartial critics state, exhibits fully as much uniformity of type as is found in most of the



ENGLISH LEICESTERS WERE USED TO SOME EXTENT

A few of the Corriedale flocks were founded by crossing English Leicester rams on Merino ewes, but as the Leicester is one of the parents of the Lincoln breed, the results from this cross do not constitute a very different element, in the Corriedale, from the results of the more frequent Lincoln X Merino cross. The above photograph shows a champion English Leicester ewe at Christ Church, N. Z., 1914. As the type of this breed has not been materially changed in the last thirty years, this undoubtedly represents very closely the animals that were used in the establishment of the Corriedale breed. (Fig. 11.)

older breeds, though not free from such differences representing ideas of individual breeders, as occur in all breeds.

Corriedales were first entered in the flock book of the New Zealand Sheep Breeders' Association in 1911. That year's volume of the flock book contains a brief history of seventeen Corriedale flocks including a total of 8671 ewes. Twelve of these make no mention of the use of any but Lincoln or Merino blood; five (containing 3400 ewes) show the use of English or Border Leicester rams at the outset with later partial use of rams from flocks bred from the Lincoln-Merino cross. It should be recalled that the English Leicester originally contributed largely in the formation of the Lincoln and Border Leicester breeds.

The following summaries of the histories of two flocks as printed in Vol. 7 (1911) of the flock book typify the work of Corriedale breeders up to 1911:

THE PROPERTY OF JAS. LITTLE

Dalmeny Park, Woodgrove, North Canterbury.

Mr. Little commenced experimenting with the view of producing inbred half-bred sheep when he was manager for the late Dr. Webster, proprietor of the Corriedale Estate, Otago. Romney Marsh and Merinos were first used; the result was entirely satisfactory, and would have been continued but for the decease of that gentleman and the sale of the property. On his taking up Allendale Estate, Waikari, Mr. Little continued to experiment.

In 1879-80 he put 4,000 large-framed high-class Merino ewes to Lincoln rams, bred by Mr. Sutton and some of the late Dr. Webster's strain. From 100 of the best ram lambs, the progeny of these ewes, a heavy cull was made, when twenty of the best were retained for service. These were mated with a pick of the half-bred ewes, the progeny of the Merino

YEARLING CORRIEDALE EWES, NOT YET SHORN

From a mixture of Merino, Lincoln and English Leicester sheep, shown in the three preceding illustrations, has resulted a new breed that is already well fixed and breeding as true as most breeds do. The representatives shown in the above photograph are owned by Leonard White, of Rakia, N. Z., and include the first prize single ewe and first and second prize pairs at the Christ Church show 1914. In a breed established so recently, from such diverse elements, it would be expected that a great deal of reversion to parent, types would manifest itself, and that it would be difficult to get a large proportion of the lambs true to standard. Such has not proved to be the case, however, and the Corriedale therefore presents to geneticists an extremely interesting instance of "blending inheritance." (Fig. 12.)

ewes, and Sutton and Webster rams, the result being a very high class type of half-bred sheep. In 1890 two rams bred by Mr. Tanner, from Merino ewes and Lincoln rams, were used, but the result was not considered satisfactory. About the same time twenty stud Merino ewes were purchased from Mr. D. Rutherford and the same number from the Horsley Downs Flock. By this means fresh blood was procured and was kept going on the line breeding until 1902, when a Corriedale ram was procured from Mr. Jas. Stringfellow. In 1909 a ram was used bred by New Zealand and Australian Land Company (Moeraki Estate). The rams used in the flock with these exceptions have all been descended from "Old Jonathan," bred by Mr. Little twenty years ago.

In 1903 the flock was transferred from Allendale to Dalmeny.

Returns for 1911.

Ewes put to ram in 1911, 858.

Ewes, four-tooth and upwards	598
Shearling ewes	260
Total	858

Lambs bred in 1910—rams, 421; ewes, 483.
Sires used in 1911, bred by owner.
Rams sold—two-tooth, 131.

THE PROPERTY OF THE NEW ZEALAND AND AUSTRALIAN LAND COMPANY LTD.

Moeraki Estate, Hampden, Otago.

This flock was founded by Mr. W. S. Davidson, at the New Zealand and Australian Land Company's Levels Estate in 1874. One thousand Merino ewes were put to Lincoln rams, and out of the produce of these ewes 150 half-bred ewes were selected for mating with rams, also out of the same ewes.

Since 1874 the progeny of these ewes have been in-bred with rams out of the same flock. The only outside blood introduced being a ram bought in 1892 from Mr. Tanner, Hawke's Bay (who had then an in-bred flock started about the same time as the Levels Estate Flock), and one ram from Messrs. Reid Bros., Darfield, in 1902, but these two rams were very slightly used. In 1904, when the New Zealand and Australian Land Company gave up the Levels Estate for closer settlement, some of the Levels Estate Corriedale Flock was transferred to the New Zealand and Australian Land Company's Moeraki Estate at Hampden, where its breeding has been continued on the same lines as in previous years, and no outside blood has been introduced into the flock since it was transferred to that property.

Returns for 1911.

Ewes put to ram in 1911, 502.

Ewes four-tooth and over	391
Shearling ewes from own flock	111
Total	502

Lambs bred in 1910—rams, 231; ewes, 257.
Sires used in 1911, bred by owner.
Rams sold—two-tooth, 223; four-tooth, 4.

The above entries show the common form of entry in the New Zealand flock book. The number of ewes bred, the origin of the sires and number of lambs raised and sold constitute the only facts recorded.

Admission of a flock to the book of record is conditional upon approval of an examining committee who regard merit and uniformity and may require the disposal of some animals before accepting the flock for record in the flock book. Most of the flocks accepted so far have been bred along the same line for from twenty to forty years. There is no regulation as to the number of generation necessary for admission to record. Continuous use of the offspring of youngest ewes would permit securing ten generations in twenty years but it never happens that all ewes are discarded after producing their first lambs. The bulk of a thirty-year-old Corriedale flock in New Zealand probably have back of them ten or twelve generations of descendants of the original crosses. One or two breeders made a special claim of having added fixity of type by always using the youngest rams available in order to increase the number of generations of selected ancestry. None of the private records permits of tabulating pedigrees to show dams for more than one or two generations, consequently Corriedale history must be read in rather a general way. The organization of Corriedale breeders recently formed in Australia requires that before being admitted to the flock book, flocks must be inbred half-breds for at least nine generations after the Lincoln-Merino foundation cross-breds. In case of breeding Corriedale rams upon half-bred ewes, six generations suffice.

It required no experiment to secure the desired type in establishing the Corriedale. The problem was entirely one of giving fixity to a type produced by crossing. The Lincoln and such English and Border Leicesters as were used may be regarded as practically of one type for consideration in this connection. The English Leicester was developed solely by selection, as its founder, Robert Bakewell, could draw

CORRIEDALES IN AUSTRALIA

Part of a newly founded flock in New South Wales. One of the most valuable characteristics of the Merino breed is its "herding instinct" which prompts the animals to keep together, and makes them manageable by shepherds. This instinct has been retained, it is said, in the Corriedale, and is a feature of great value to the new breed. (Fig. 13.)

upon no highly improved mutton sheep in the last half of the eighteenth century. In ancestry and in many commercial characteristics the Merino is about as dissimilar to the long wools as can be found without going to the central Asiatic types.

CONSTANT CULLING

The main work of the New Zealand Corriedale breeders seems to have been in the culling of rams and ewes. As shown in Mr. Little's flock, twenty ram lambs were retained from the offspring of 4,000 ewes. At the Moeraki estate 150 ewes were selected from the progeny of 1,000 ewes. Such vigorous culling surely allowed uniformity. We have no records as to the percentage of discards from the second and subsequent generations, but 1911 reports indicate that culling is not light as the number of yearling ewes is not far below half that of the older ones. From my observations on New Zealand farms I did not conclude that Corriedale breeders now cull heavier than owners of flocks of other breeds. The vigorous culling in the earlier stages need not be taken to show particular clearness of aim on the part of the breeders, as it is doubtful if they then looked forward to the status of a breed. Sheep were cheap and the best of the half-breds were retained in a separate flock as the most logical method of obviating the need of pure long wool and Merino flocks to produce fresh stock ewes. The discards were sold or used with rams of the common breeds.

The fact that many of the opposed characters of the Lincoln and Merino appear to have blended and that the blended form is now uniformly transmitted does not harmonize with present day understanding of the probability of segregation of the factors composing a character. With coat characters such as length and fineness of fiber so opposite as they are in the Lincoln and Merino, one might expect here at least frequent

reversions to the length or to the fineness of one of the parent stocks. Among the several hundred Corriedales I saw and the scores I examined closely not one had wool anywhere nearly as short as the longest wooled Merinos, as coarse as the Lincolns, or as fine as the Merino. Many of the lots examined were either ram or ewe hoggets that had not been culled, consequently it could not have been that reversions had occurred and been discarded. These characters may be determined by a number of factors each separately heritable but their number and irregularity of transmission must be beyond hope of elucidation or practical control. In length of wool fiber Corriedales more nearly approach the Lincoln than the Merino, though I cannot say that any I saw fully equalled in this respect Lincolns grown under similar conditions.

HORNS STILL APPEAR

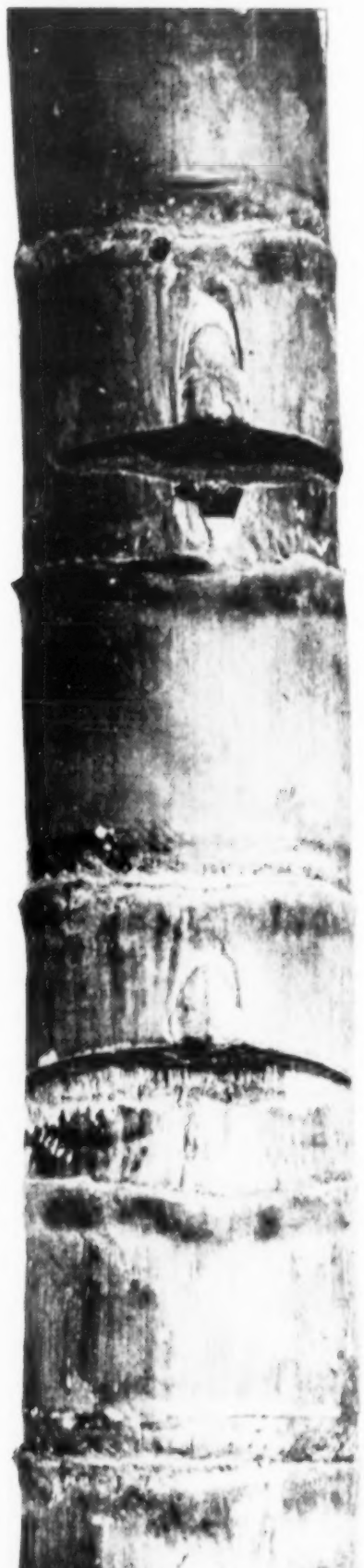
The horned character still crops out quite frequently, one breeder having stated that 5% of his 1914 lamb crop were culled because of horns, which could only have come through the female line as both sexes of the original crossbreds were from the hornless Merino ewes and Lincoln rams. Horns in the long wool breeds are of exceedingly rare occurrence.

Body characters are less easily followed than those of fleece. The most common conformation of the Corriedale is practically intermediate between the Lincoln and Merino in respect to width of back and loin, depth of body and development of the rump and twist. In some flocks where fineness of wool has been emphasized, the narrower chests and the throat folds of the Merino are seen, though none of the sheep examined after shearing could be mistaken for either Lincoln or Merino by anyone familiar with these breeds.

The comparative newness of the Corriedale and the fact that it does not come from Europe have called forth considerable argument against the possibility of the breed's being of a fixed type. Strangely enough the fact is overlooked that at least one of the British breeds now quite popular here was originated by crossing animals from two distinct breeds, and most of the other breeds of sheep at some stage of their existence have received the impress of older breeds and have been rendered true to a type embodying characters of the outside blood.

Peacock-Guinea Fowl Hybrids

The cross between pea fowl and guinea fowl is a very "wide" one that has been made a number of times. The latest recorded success is that described by D. Brentana in the *Moderno Zooiatro*, No. 11, 1914. In general appearance the hybrids most closely resemble the peacock, their form being slender, particularly in the head and neck, although there was a noticeable absence of all the characteristic appendages of the head, and the great train of feathers which is the peacock's pride was very much reduced. The plumage exhibited striping, which is perhaps a primitive pattern in the pea cock. It was of a dark fawn with black stripes in the lower part of the neck, becoming paler fawn with black specks in the region of the thorax, abdomen and flanks. As such hybids are usually absolutely sterile, it is impossible to breed them through several generations and work out the manner of inheritance of the various characters involved.



SUGAR CANE THAT OUTGREW ITSELF

An unusual abnormality in sugar cane is shown in the accompanying photograph from H. B. Cowgill, plant breeder of the Insular Experiment Station, Rio Piedras, Porto Rico. "This stalk," he writes, "was taken from a seedling cane which was grown here in the year 1913. The photograph shows four complete internodes or joints of a stalk; each of these joints has, as usual, a bud growing from it. But in every case, it will be observed, this bud is transversed squarely across the middle by a great fissure. All the stalks of this seedling showed this abnormality on many of the internodes. As may be seen, it is a rupture of the outer portion of the stalk across the center of the bud. Seedling canes frequently show peculiarities, but this is the first time I have known this particular abnormality to happen. It seems to have been caused by an unusual formation of the bud. In sugar cane the point of the bud is usually free from the stalk, but in this case it adhered closely to the stalk and seemed to have grown fast to it. The bud within evidently developed faster than the stalk, while its outer scales could not do so on account of being fastened to the latter. The pressure produced seems to have been sufficient to rupture the stalk. It was not possible to make any test to determine whether this abnormality would be inheritable." (Fig. 14.)

Genetics Literature

THE annual reports of the AMERICAN BREEDERS' ASSOCIATION, published in seven volumes, form the most valuable collection of material for students of genetics which has been published in the United States. Most of them are out of print and are becoming very valuable. All of them are nearly indispensable to libraries, institutions and students of plant and animal breeding, heredity, variation, eugenics, or genetics in general.

The Association still has on hand a limited number of copies of three of these reports, which it offers for sale.

Vol. VI, Proceedings A. B. A. (1910), contains 465 pages. Illustrated. It includes 80 papers on general genetic subjects, and among the contributors are practically all the leaders in this study in the United States. **Issued at $2, now offered for $1.**

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The volumes are substantially bound in cloth and will be sent post-paid on receipt of price.

As the Association frequently receives requests for other volumes of the proceedings, which are now out of print, it will be glad to hear from those who have copies for sale or exchange.

In addition to its annual reports, the Association still has on hand a few copies of the following issues of the AMERICAN BREEDERS' MAGAZINE:

Vol. I, Nos. 2 and 4.
Vol. II, Nos. 3 and 4.
Vol. III, No. 2.
Vol. IV, Nos. 1 and 4.

JOURNAL OF HEREDITY:

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THE AMERICAN GENETIC ASSOCIATION

511 Eleventh Street Northwest **WASHINGTON, D. C.**

WHAT GENETICS IS

"An exact determination of the laws of heredity," says William Bateson, "will probably work more change in man's outlook on the world, and in his power over nature, than any other advance in natural knowledge that can be clearly foreseen."

To gain this knowledge is the object of the science of genetics, which proceeds, in practice, largely by means of plant breeding and animal breeding, for the reason that heredity is less complicated in these organisms than in Man, and its operation can be more easily made out. The knowledge so gained finds its application in methods for the improvement of cultivated plants and domesticated animals and, most important of all, in the improvement of the human race through the science of eugenics, which was defined by its founder, Francis Galton, as "the study of agencies under social control that may improve or impair the racial qualities of future generations, either physically or mentally."

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is an incorporated organization, co-operative in nature and devoted to promoting knowledge of the laws of heredity in the broadest sense of the word, and their application to the improvement of plants, animals, and human racial stocks. It is the largest organization in the world for the advancement of genetics, and its organ, The Journal of Heredity, is the most important agent for furthering the interchange of ideas between investigators of different phases of these problems, and for the presentation of their results to the public.

Through its committees on research, co-operation with which is not obligatory, but is urged upon every member, the association collects information by means of approved scientific methods applied to the subject of genetics. This information, as well as that derived from other authoritative sources, it endeavors to place before the public by means of its committee on education and extension, and before its membership, in an attractive and understandable way, through this magazine. The association constantly strives to further the cause of conservative, constructive science and to check the progress of fallacious and sensational pseudo-science. While it can not assume responsibility for the accuracy of statements made by contributors to The Journal of Heredity, it endeavors to publish only such as are on a sound scientific basis, and members are urged to contribute such articles, with illustrations. The magazine does not pretend entirely to cover the immense field of genetics, but it is designed to keep members informed of the latest results in research in the most interesting lines, and to present these results in such a way that they will appeal not only to the specialists, but to the general reader who desires to know what the specialists are doing in a science that is of such personal importance to each individual.

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